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Assessing linkages between petroleum platforms and pelagic fishes using telemetry with emphasis on blue runner (Caranx crysos)

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ASSESSING LINKAGES BETWEEN PETROLEUM PLATFORMS AND PELAGIC FISHES USING TELEMETRY, WITH EMPHASIS ON BLUE RUNNER (*CARANX CRYSOS*)

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ABSTRACT

Petroleum platforms number greater than 4,200 in the Gulf of Mexico and *Caranx crysos* (blue runner) is one of the most abundant fish species around these platforms. Forty-six blue runner were tagged with acoustical transmitters in August 2005, though the study was terminated prematurely due to the impending arrival of Hurricane Katrina. Nineteen blue runner were tagged in September 2006 and tracked for up to two months. Blue runner exhibited limited site fidelity around the platforms in 2005. The home range of twenty-three blue runner was calculated in 2005. A significant difference was found between the fork length of the fish and their overall 50% range, but their overall 95% range. The reverse was true when comparing mean daily ranges and fork length. The daytime core ranges were generally larger than the nighttime core ranges, though not significantly so. In 2006 tagged fish were released at unmanned platforms and all but one returned to the main complex and remained there over the course of the study period. The size of blue runner schools was estimated to be 36m. They were found to school more during the day than at night and moved between schools showing no preference for schooling with a particular fish. The blue runner showed a distinct diel vertical migration pattern with a marked descent to about 25m at night and ascent to the surface in the morning. The rate of ascent was significantly greater than the rate of descent. There was no relationship between these rates, the amplitude of migrations and maximum nightly depths with the lunar periodicity. There was a significant difference between the nighttime distribution of blue runner at the unmanned platforms and the manned platforms with fish at the unmanned platforms having a greater mean depth. The swimming speeds of tagged blue runner were greater during the day than at night and were indicative of passive foraging behavior. The lighted manned platforms appear to allow for greater foraging opportunities at night than the unmanned platforms.

CHAPTER 1

INTRODUCTION

1.1 Petroleum Platforms

The first offshore petroleum platform was erected in the Gulf of Mexico (Gulf) in 1948. Since then, more than 7,000 offshore platforms have been constructed around the world. More than 65% of these platforms are located in the Gulf, with the remaining platforms in the Northwest Pacific Ocean, the North Sea, off the coasts of the Middle East, Africa, Australia, Asia and South America (Wilson and Heath, 2001). Currently, the number of petroleum platforms in the northern Gulf exceeds 4,200 (MMS, 2007). These constitute over 99% of the platforms associated with the offshore petroleum production in the United States (Wilson and Heath, 2001).

Platforms in the Gulf serve as a destination for many of the commercial and recreational fishers in Louisiana. Reggio (1987) estimated that over 70% of all recreational fishing trips within the U.S. Exclusive Economic Zone (more than three miles from the shore) occurred near platforms. Platforms serve as artificial reefs and provide a hard substrate, which is in contrast to the clay silt or sand substrates typical of the northern Gulf. Gallaway and Lewbel (1982) estimated an additional 50 km^2 of artificial reef are provided by offshore petroleum platforms, increasing total reef habitat in the northern Gulf by 27%. (This was calculated by estimating 8,173 m^2 of hard substrate provided by the vertical structure of the average platform and an additional 3,750 m^2 of hard substrate provided by the lost equipment and dislodged shelled organisms under the typical platform.)

Over time the useful life of a petroleum platform ends, and the structure must be removed, in accordance with federal law. Since 1973, over 1,500 platforms have been removed from the Gulf. In 1984, Louisiana Congressman John Breaux authored the National Fishing Enhancement Act (PL-98-623), which mandated a long-term plan for the installation, monitoring, and maintenance of artificial reefs within the Gulf. Two years later Louisiana passed the Louisiana Fishing Enhancement Act (Act 100), which set up a procedure for transfer of ownership and liability of decommissioned petroleum platforms from the oil and gas companies to the State once the useful life of the platform had ended and production had ceased (Kasprzak, 1998).

In addition to hard substrate, petroleum platforms provide three-dimensional structure, which extends throughout the water column. This structure may provide protection from predation, habitat that may potentially increase the growth and survival of individuals, and may serve as a visual attractant for pelagic fishes (Stanley and Wilson, 1997). The platform also provides a surface for the settlement and recruitment of animals such as barnacles and mussels, which require a hard substrate for growth. The establishment of these colonies in turn attracts prey, such as zooplankton and larval fish. The presence of smaller prey species attracts larger pelagic fishes. Fabi *et al.* (2004) found that both species richness and total biomass were higher at platforms than at open-sea control sites in the Adriatic Sea. Soldal *et al.* (2002) used acoustics to measure the distribution of fishes near a platform in the North Sea and found the highest densities of fish were found in the bottom 10 m of the water column. In addition, Soldal *et al.* (2002) used underwater video observations and found cod remained near the legs of the platform, where they could not be measured acoustically, during the day but moved away from the platform at night. In the Gulf, fish densities are consistently higher in the area adjacent to platforms, up to 10.5 fish m^{-3}, with densities decreasing to those typical of the open waters of the northern Gulf (<0.02 fish m^{-3}) only 50 m from the platform structure (Stanley and Wilson, 1997, 1998).

In addition to the hard substrate provided by petroleum platforms, manned platforms provide an artificial light field. These platforms utilize floodlights approximately 20 – 40 m above the water's surface to provide light for night crews and as a navigational aid. In addition the flare stack, used to burn off excess flammable gases, can illuminate the water periodically. Unmanned platforms generally only utilize minimal lighting for navigational purposes and do not produce an artificial light field of comparable intensity. Keenan *et al.* (2007) measured the extent of the nocturnal artificial light field around the main complex of platforms in the South Timbalier 151 field, off the coast of Louisiana. Using a profiling reflectance radiometer they found the light field from the platform illuminated the surrounding waters to a depth of 20.5 m, the maximum depth sampled, and extended outward more than 100 m from the nearest manned structure. The intensity of the nocturnal artificial light field was 10 – 1000 times greater than ambient light at control sites located 1 km from the platform, clearly overwhelming any lunar light influences. They concluded the artificial light field may provide an enhanced foraging environment for larval, juvenile and adult fishes by concentrating phototaxic prey species and allowing for easier location and capture of prey.

1.2 Artificial Reefs

Natural reefs are highly productive due to the hard substrate, which provides surface for recruitment as well as protection from predation. Artificial reefs also provide these benefits and are often surrounded by soft substrates with little topographic relief. The introduction of the hard substrate can transform an area with low productivity into a highly productive one. Many mechanisms have been suggested for this transformation including increased food availability, increased feeding efficiency, increased shelter from predation, and increased recruitment habitat (Randall, 1963; Matthews, 1985);

however, the evidence for these mechanisms appears to be circumstantial (Bohnsack, 1989).

The scientific theories regarding the function of artificial reefs involve two opposing ideas, attraction theory and production theory. The basis of the attraction theory is that the hard structure of the artificial reef will attract fish to the region and increase the biomass of the reef. The underlying process is one of trophic succession. In the beginning stages of the artificial reef the planktonic larvae of corals, barnacles, and other sessile organisms will settle on the hard substrate. Once the sessile organisms have settled, other planktonic and benthic organisms, which feed on the sessile animals, will migrate or settle on the artificial reef. This trophic succession continues until the higher-level predators are attracted to the reef, in response to the new community.

The production theory is associated with two hypotheses. The first involves the idea of providing a region for larval fish to settle. This assumes that the amount of appropriate habitat for settlement in the region without the artificial reef is either minimal or nonexistent. By providing a substrate for settlement the artificial reef allows for the increased production of fish biomass. The second hypothesis involves the structure of the artificial reef and its ability to provide refuge from predators and a concentrated food supply. This allows the fish to avoid predation and expend less energy searching for food, thus extending reproductive output, lifespan, and overall biomass of the fish population.

In an attempt to investigate the attraction theory Polovina (1989) used data from the Japanese artificial reef program. The Japanese spent over $4.2 billion between 1976 and 1987 to build and deploy 6,443 artificial reefs, but found no measurable increase in coastal fishery landings. In addition, one artificial reef site attracted some species, but repelled others, leading to the finding that an artificial reef may have negative effects on some species. Polovina determined the artificial reefs can serve as fish aggregators, but did not increase standing stock.

Conversely, Grossman *et al.* (1997) looked at the existing data to determine if artificial reefs increased fish production. Their review focused on the concept of habitat limitation. They determined that if habitat is limiting, artificial reefs could increase fish production in one to three ways: Increase in the foraging habitat of individual fish ,whether larvae, juvenile or adult, Increase in the nesting habitat of adult fishes; and increase in refuge habitat. They point out hard bottom substrate availability may not limit regional fish production, in which case artificial reefs only serve to redistribute existing fish biomass.

Grossman *et al.* (1997) looked at five situations where habitat could be limiting for fish, including the relationship between habitat and abundance, the reduction in available habitat, the limitation of refuge, the effects of recruitment on population size, and resident removal studies. Previous studies reviewed by Grossman *et al.* found a positive relationship between the amount of habitat availability and reef fish biomass and concluded that increases in habitat lead to increases in biomass (den Boer, 1978; Luckhurst and Luckhurst, 1978; Roberts and Ormond, 1987). Grossman *et al.* (1997) refute this as evidence of production because the studies did not require that habitat be a limiting factor and cannot fully explain the increase in fish biomass.

The second situation examined was the effect of reduction in available habitat. Reduction in habitat has been demonstrated to have a number of causes, including hurricanes (Kaufman, 1983), water temperature anomalies (Wellington and Victor, 1985) and biological agents, such as crown-of-thorn starfish (*Acanthaster planei*) (Sano *et al.,* 1987). Grossman *et al.* (1997) stated that the increase in corallivorous fish biomass may be affected by reduction in coral reef habitat, but this is not necessarily true in noncorallivorous fishes. Because of the large number of factors that cannot be controlled, the effect of adding artificial reefs as habitat to offset reductions in habitat limitation cannot be directly attributed to an increase in production.

In the third situation investigated the limitation of refuge. Previous studies found that it may be possible for an increase in refuge area to result in an increased abundance of fish (Bohnsack, 1982; Doherty and Sale, 1985; Hixon, 1991). Grossman *et al.* (1997) stated that the local increase in biomass resulting from increased refuge may not scale up to the regional level, and it is not clear if the biomass is controlled by refuge limitation or recruitment limitation.

The fourth situation dealt with recruitment variation. Recruitment and post-recruitment processes can be factors influencing adult population sizes on artificial reefs (Doherty, 1991; Jones, 1991; Tolimieri, 1995). Hard-bottom habitat is not a limiting resource for fishes and population size can also be influenced by food availability and complex social interactions. In addition, the effect of population size and the processes affecting biomass can differ between species, so no overarching theory may be derived from the effect of individual species recruitment success.

The final aspect dealt with the removal of resident species. If habitat were limiting then recruitment following the removal of resident species would increase to pre-removal levels. The results of previous studies show very different results from resident species removal, including increased recruitment (Shulman, 1984 and 1985), no change in recruitment (Doherty, 1983; Sweatman, 1985), and decreased recruitment (Jones, 1987; Tupper and Boutilier, 1995). Thus removal experiments are inconclusive with respect to the role of artificial reefs and increased fish production. Grossman *et al.* (1997) conclude that there is insufficient evidence to support the hypothesis that habitat is limiting to most reef fish populations and thus the data is not able to support the production theory.

Powers *et al.* (2003) studied attraction/production surrounding petroleum platforms utilizing three different scenarios. In the first scenario the increase in fish production is a result of aggregating fish that already existed in the system (attraction theory). In the second scenario adding artificial reef habitat increases recruitment, which is previously limited by habitat, or by increasing growth, which is previously limited by refugia (production theory). In the third scenario recruitment and growth are increased by the addition of artificial reef habitat, but expected increase in biomass is offset by the increase in fishing mortality.

To address the first scenario previous studies were discussed which indicated that fish do not colonize the reefs as early recruits, but instead migrate from other reefs at a larger size. They suggested that the new fish were growing and generating secondary production at another site. Therefore the new artificial reef did not increase recruitment, but whether or not the reef increased production or growth was unclear.

Under both scenarios two and three (enhancement scenarios), the reef showed an increase in production based on the increased availability of foraging opportunities. Scenario two provides the fish with more refuge opportunities and thus allows for predation avoidance. Thus an increase in production may be viable if reefs are installed as part of a marine reserve.

While scenario three is similar to scenario two it does include fishing pressure and leads to a different outcome. The production of fish could be increased due to the enhancement, but any increase may have been offset by the reduction of targeted fish populations through the removal of the largest and most fecund individuals.

Bohnsack *et al.* (1997) also reviewed the artificial reef attraction/production argument. The review stated that most artificial reef managers assume that habitat is limited and that the addition of artificial reefs will alleviate the limitation. Most reef ecologists, however, believe that populations are actually recruitment limited. Bohnsack *et al.* go on to state that additional artificial reefs may ultimately lead to the depletion of already overfished species by aggregating them and making them more vulnerable to fisheries. Bohnsack *et al.* believe the initial problem with artificial reef research is the lack of large spatial and temporal studies. Such data could help to determine if the recruitment variability is natural or related to the introduction of artificial reefs. They point to a 30-year study in Japan showing that most of the variability in fishery populations was due to variation in recruitment of fish from surrounding areas to the artificial reefs. A second shortcoming of previous research has to do with the relative size of artificial reefs compared to natural reefs. Even when habitat is limited, the impact of the artificial reefs can be negligible due to the small amount of artificial reef area compared to that of natural reefs. Additionally, many studies erroneously conclud that an increase in fish densities and biomass is a direct result of increased production related to the artificial reef, when other mechanisms cannot be rejected. Finally, the density and survival of juvenile fishes is related to the complexity and scale of the artificial reef. Smaller, more complex reefs better support high densities of juvenile fishes, leading to the need for additional research in the area of creating structures which would mimic this natural complexity.

1.3 Blue Runner (*Caranx crysos*)

The blue runner (*Caranx crysos*) (Fig. 1.1) is a member of the family Carangidae, which contains the jacks and pompanos. Carangids are primarily marine fishes that are fast swimming predators. Slender caudal peduncles, high aspect ratio caudal fins, and finlets behind the dorsal and anal fins characterize the family. Blue runner are a schooling species, which can often be seen feeding at the surface. The largest recorded blue runners caught in the northern Gulf of Mexico based on state record data provided by state Wildlife and Fisheries agencies were: 4.31 kg, 720.8 mm TL (Texas); 3.37 kg (Louisiana); 3.09 kg (Mississippi); and 5.01 kg (Alabama). The blue runner has an estimated life span of up to 11 years (Patillo *et al.*, 1997).

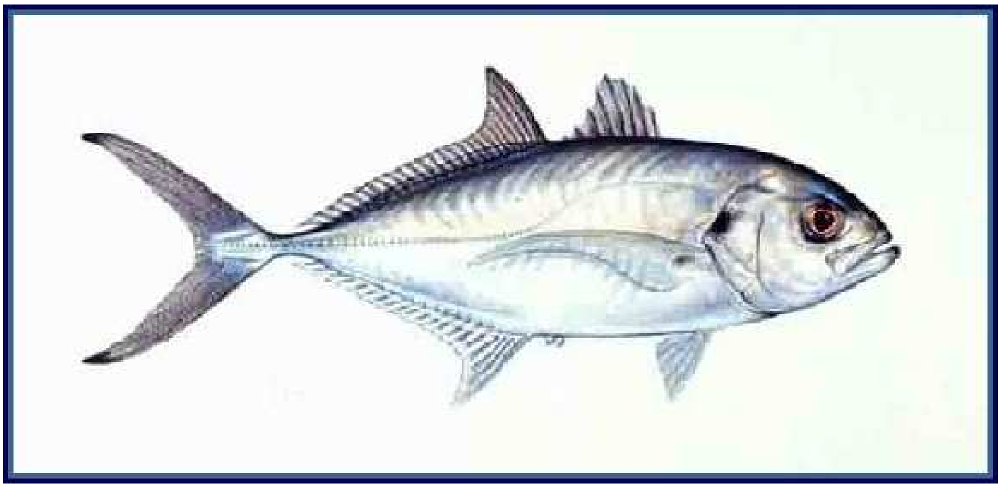

Figure 1.1. Artist rendition of an adult blue runner. Image from http://www.rwhs.com/saltwater/fla_sltwtr_blue_runner.htm

The known distribution of blue runner in the Western Atlantic ranges from Nova Scotia to Brazil (McKenney *et al.*, 1958). Swaby *et al.* (1996) reported the first records of blue runner off the southern coast of Britain in 1992. Within the Gulf blue runner are abundant from April to September between Tampa Bay, Florida and Rio Grande, Texas (Goodwin and Finucane, 1985). They are commonly associated with petroleum platforms where they can be seen in large schools feeding at the surface. Dooley (1972) found blue runner to be one of the eight most abundant fishes associated with *Sargassum* communities, dominating in number between March and October, but declining significantly between November and February. A limited commercial fishery for blue runner exists in the Gulf. Commercial catch rates from the Gulf between 1994 and 2003 show a low of 36,638 individuals landed in 2000 and a high of 2,818,515 individuals landed in 1998. Recreational fisheries commonly use blue runner as baitfish for larger predatory fishes such as tunas and billfishes.

McKenney *et al.* (1958) studied larval specimens of blue runner collected by plankton tows. By 6 mm standard length (SL) they had developed all the structures of an adult fish, but the structures were in different stages of physiological development. Across a size range of 8.5-12.0 mm the fish left the postlarval stage and became juveniles. Goodwin and Johnson (1986) used otoliths of commercially captured blue runner to model growth and mortality rates. They are fast growing and attain about 75% of maximum size within the first 3-4 years of life. The mortality rate for blue runner was similar to that of king mackerel, though the limited commercial fishery for blue runner allows for the existence of a larger number of older individuals. Goodwin and Johnson (1986) estimated relationships between standard, fork, and total lengths as well as length to weight for blue runner. Calculation of the growth coefficient by Goodwin and Johnson (1986) showed that females grow at a slightly faster rate than males, but that males reach a larger asymptotic length.

Male blue runner become sexually mature at approximately 225 mm SL (Berry, 1959), while females do not mature until approximately 267 mm FL (Goodwin and Finucane, 1985). Reproduction peaks during summer months and also occurs during late spring and early fall in the Gulf of Mexico. Evidence suggests there may be two peak spawning periods, though: April–May and August-September (Goodwin and Finucane, 1985; McKenney *et al.*, 1958). Goodwin and Finucane (1985) always found females to be more abundant than males, though they admit that may have been an artifact of sampling methods. Fecundity ranged from 41,000 ova in a 288 g fish to 1,546,000 ova in a 1,076 g fish (Goodwin and Finucane, 1985).

Ditty *et al.* (2004) found the highest concentrations of blue runner larvae in the Gulf in the summer (June-August), with lower numbers in the spring and fall; though they suspect gear bias may have undersampled the total number of blue runner. McKenney *et al.* (1958) found post-larval forms of blue runner in the Gulf in every month except September and November, though about 75% of all postlarvae were caught between April and August. Leak (1981) found both larval and juvenile specimens of blue runner were common in collections at depths greater than 50 m during May-July.

The diet of the blue runner is varied. Schekter (1972) studied the feeding of larval and juvenile fishes in the Florida Current and found that larvae and juveniles fed primarily on calanoid copepods, followed by cyclopoid copepods, amphipods and chaetognaths. McKenney *et al.* (1958) found that blue runner larger than 10 mm fed on copepods, ostracods, amphipods, decapod crustacean larvae and fish eggs. No larval fish were found in the gut contents until the specimens reached 44mm. Dooley (1972) found similar gut contents for blue runner associated with sargassum communities. Keenan (2002) and Keenan *et al.* (2003) examined the diet of adult blue runner around petroleum platforms in the Gulf. They found that the blue runner diet was dominated by zooplankton (decapod crustaceans, larval stomatopods, chaetognaths and hyperid amphipods), with some cephalopods and larval fishes found in the guts. While blue runner fed during the daylight hours and after dark, there was a peak in feeding during the predawn and early morning hours as determined by gut fullness. Blue runner stomachs rarely contained small zooplankton, such as crab zoea or megalopae.

Dual-beam hydroacoustic and visual count surveys at a platform in 22 m of water approximately 80 km south of Cameron, Louisiana, near the Louisiana/Texas border recorded nineteen species of fish, but only five of the species were seen on every visual survey performed (Stanley and Wilson, 1997). During the surveys Atlantic spadefish

(*Chaetodipterus faber*), red snapper (*Lutjanus campechanus*) and blue runner (*Caranx crysos*) were numerically dominant. Blue runner abundance was variable, but constituted 45.3% of all fishes in the May 1992 sampling, with 9,580 individuals recorded. During the course of their study blue runner constituted 20% of all fishes recorded. Hastings *et al.* (1976) performed visual surveys of platforms in the Gulf, off the coast of Panama City, Florida, between 1970 and 1974 and blue runner was the only fish species noted in every count.

The relationship between petroleum platforms and fishes is still not well understood. The abundance of blue runner around platforms makes them good candidates for studying this relationship. Keenan *et al.* (2003) showed that the fish feed during both day and night, but they were unable to distinguish the location of the blue runner over a diel cycle. Artificial reef theories also suggest that fish may use the platforms as a refuge from larger predators. The use of acoustic telemetry to determine the accurate position of the fish can allow for the resolution of these two questions with regards to blue runner.

1.4 Acoustic Telemetry

Underwater biotelemetry has been in use since the 1950's when Trefethen (1956) began to work on the instrumentation and Johnson (1960) began applying it to following the migration of adult Chinook salmon. Since then telemetry has been used to study aspects of the ecology of numerous fishes, including cod activity patterns (Cote *et al.*, 2002), behavior of European eel (Winter, 2005), swimming performance of rainbow trout (Mellas, 1985) and blacktip shark mortality (Heupel, 2002), among many others.

The early history of acoustic telemetry began in the 1950's with the US Navy's Sound Surveillance System (SOSUS). SOSUS was a system of passive hydrophones used to track submarines during the Cold War. By matching the known sound signatures of Soviet submarines, with the differential times of arrival of the sound at various SOSUS hydrophones in known locations, the system was able to estimate the location of the targets. Some of the technology developed for SOSUS was eventually adapted for use in scientific research. The passive hydrophones were used to monitor the movement of cetaceans. Most individual cetaceans have vocalizations that are distinctive. The times of arrival of calls from single individuals at a series of surveyed hydrophones allowed their position to be localized. Over the decades advances in technology and the use of active acoustics allow for more accurate estimates in the position of internally and externally tagged animals.

Radio telemetry is often used in tracking wildlife, but ultrasonic (acoustic) telemetry is better suited to use in salt water and when precise locations of animals are needed (Stacko and Pincock, 1977). In salt water radio signals attenuate quickly, which makes its use in large study regions difficult. For a given water temperature and salinity, acoustic signals will propagate omnidirectionally at a constant velocity (Voegeli and Pincock, 1996). The typical frequency range used for tracking studies lies between 60 and 300 kHz. Because sound energy losses due to absorption are proportional to frequency, lower frequencies have a greater potential for tracking studies (Lucas and Baras, 2000).

Detection of a tag’s pulse can show that a tagged animal is present in the study area using a single hydrophone. Additionally, a single hydrophone can be used to track the movement of a tagged animal by allowing a researcher to follow the animal in real-time. Two hydrophones can be deployed over opposite sides of a boat and if a tagged animal is detected the boat can be steered in the direction of the movement of the animal by comparing the signal strengths of the hydrophones. Single hydrophone studies can also be used to localize the positions of one, or a few individuals. By estimating a bearing to the target based on signal strength, and then moving to a second location where another bearing is obtained, the position of the animal can be estimated using the intersection of the two bearings. This estimate can have a large error if the animal moves during the two bearing measurements. Examples of studies using this technique include Hines *et al.* (1995) and Wolcott and Hines (1990).

To determine the two-dimensional position of a tagged animal, a pulse must be received by a minimum of three fixed hydrophones in an array. The more hydrophones in the array that receive the signal the more precisely the determination of the tagged animal's position can be estimated. The position is then calculated by triangulation using the difference in sound arrival time at each hydrophone and a mathematical algorithm (Watkins and Schevill, 1972). Once an acoustic signal has been received by a pair of hydrophones, the reciprocal lines of constant time delay between the two hydrophones can be used to compute two possible locations for the source of the sound. When that same signal is received by a third hydrophone the line of constant time delay can then be combined with those of the other two hydrophones to determine a single estimation for the location of the sound source. To further refine the estimation of the location additional hydrophones would need to receive the same signal. The use of multiple hydrophones to triangulate the position of a tagged animal (localization) allows the researcher the ability to accurately estimate the location and movement of an animal, rather than simply track the animal and determine the presence/absence pattern within a given area.

There are four main components of an acoustic transmitter (tag): transducer, battery, electronics and encapsulation. In the application of acoustic telemetry, cylindrical transducers are used as they allow for omnidirectional radiation of acoustic pressure waves at ultrasonic frequencies. The transducer emits the acoustic pulse. The battery is the largest and frequently, the heaviest component. The life of the battery is determined by the interval at which an acoustic pulse is emitted from the transducer and the amount of energy imparted by each pulse. Shorter intervals between pulses reduce the life of the battery. The electronics within a tag control the timing of the pulses, encoding of additional information in each pulse, and collection and interpretation of environmental data, such as temperature and pressure, which may be transmitted by the tag. Finally, the encapsulation is a hard, waterproof shell, which encases all the other components.

The method of attaching the tag varies with the animal studied. In larger animals, such as dolphins or sharks, a tag can be attached to a thick plastic string and attached through a puncture in the dorsal fin. For smaller fishes attaching a tag to a fin would create difficulty in swimming, cause undue stress on the animal and probably result in tag loss. There are two methods for attaching tags to smaller fish, oral and surgical implantation.

Oral implantation of the tag requires the fish to be induced to physically swallow a tag. The tag will remain in the digestive tract for a short time until it is excreted. This method has two drawbacks. First, the tag may not remain in the fish for the desired length of the study, leading to a limited amount of data. Second, the introduction of a large plastic capsule into the digestive system of a fish may interfere with normal feeding habits.

During surgical implantation the fish is anesthetized, an incision is made (usually on the ventral side), and the tag is inserted into the peritoneal cavity. The incision is then closed and the fish is allowed to recover before being released. The surgical method is the most difficult method as it requires fish that are sufficiently large so that their peritoneal cavity can accommodate the tag without adversely impinging on internal organs. Tag expulsion has been seen in channel catfish (Summerfelt and Mosier, 1984) and rainbow trout (Chisholm and Hubert, 1985).

To simultaneously track multiple fish the acoustic tags must be individually coded so each tagged fish can be distinguished. Lotek Wireless developed the acoustic telemetry application of code division multiple access (CDMA) technology making the tracking of multiple fishes using the same acoustic frequency possible. CDMA technology is used in both Global Positioning Systems and cellular telephony to allow multiple users access to the same frequency without interference. Because the correlated noise associated with dissimilar codes is a factor of ten or lower than the correlated noise associated between identical codes, CDMA technology overcomes difficulty of signal overlap (Niezgoda *et al.* 2002). The use of CDMA technology has a number of benefits, including low signal-to-noise ratio and improved code discrimination that allow for precise (sub-meter) positioning of tagged fish.

Additional types of acoustic tags are available for use in telemetry studies. Passive integrated transponder (PIT) tags are small units that can be internally implanted in relatively small animals. Bubb *et al.* (2002) implanted PIT tags in crayfish and were able to track more than fifty animals for 182 days. In addition, satellite pop-up tags can be used to monitor long-range and long-term movements of animals. These tags archive the data and are released from the animal at a predetermined time and, upon reaching the waters surface, transmit their data to the Argos satellite. The data from these tags are archived and analyzed using the Satellite Tracking and Analysis Tool (STAT) (Coyne and Godley, 2005). These tags have the disadvantage of being costly and the data recovery rate is lower than with other forms of tags.

1.5 Surgical Tag Implantation

Surgical implantation of acoustic tags is the most common method for tagging small to medium-sized fishes. Given the invasive nature of this method, it is important to understand the possible physiological or behavioral effects of the internal tag insertion. Successful telemetry studies require healthy tagged fish whose behavior is unbiased by the capture, implantation, or presence of the tag.

Fish can be captured using electrofishing (Jennings and Looney, 1998), nets (Sakaris *et al.*, 2005) or barbless hook and line (Cote *et al.*, 1999). Regardless of the capture method used it is important to minimize physical damage to the fish. This includes using latex gloves when handling the fish. Cooke and Wagner (2004) surveyed researchers who perform surgical implantation of tags and found that two aspects effecting the survival of tagged fish are the amount of training and experience the surgeon has in the technique, with the higher levels leading to higher survival rates.

A commonly used rule of thumb in determining the relative sizes of fish and/or tag is that the tag weight should not exceed 5% of the weight of the fish out of the water. This guidance is based on the assumption that heavier tags would affect the swimming performance of tagged fish (Winter, 1983). Recently researchers have begun to question the validity of this rule. Brown *et al.* (1999) found there was no relationship between weight and swimming performance among fish with surgically implanted tags ranging from 6-12% of the fish's weight. Jepsen *et al.* (2005) suggest tag volume, position of the tag in the peritoneal cavity, and overall tag dimension be taken into account to determine the effect on buoyancy and to minimize impinging on the internal organs.

Anesthetics to sedate fish for surgery have been in use for decades. The two most common anesthetics are clove oil (not legal in the United States) and MS-222 (tricaine methane sulfonate). In preparation for surgery the fish is placed in water containing the anesthetic and the fish absorbs the compound through the gills until sedated. Care must be given with regards to the exposure time as anesthetics can kill the fish if it is left in the solution for too long. Clove oil is a distillate of the clove tree (*Eugenia aromatica*). It is 90-95% eugenol (Nagababu and Lakshmaiah, 1992) which is also used as a flavoring for food and as a topical dental anesthetic. Anderson *et al.* (1997) compared the efficacy of clove oil and MS-222 and found the two compounds were equally effective, but fish anesthetized with clove oil require a longer recovery period. In addition, clove oil has been shown to cause cardiorespiratory depression and death in Acanthuridae (tangs and surgeonfish) (Harms and Lewbert, 2000). MS-222, a primary aromatic amine, is the most commonly used fish anesthetic in the United States. Hunn *et al.* (1968) found MS-222 returned to background levels after eight hours of recovery by excretion or removal extrarenally (primarily over the gill epithelium). After 24 hours of recovery the concentration of MS-222 in rainbow trout declined below the detection level of 0.1 ppm (Marking and Meyer, 1985). No long-term effect was seen in the swimming performance of rainbow trout after sedation by MS-222 (Anderson *et al.*, 1997).

After the tag is inserted the incision must be closed. One option is the use of cyanoacrylate adhesive, also known as surgical glue. Petering and Johnson (1991) tested surgical glue on black crappies, with limited success. The use of surgical glue reduced surgery time by 38%, but none of the adhesive remained on the incision after three days, resulting in transmitter loss through the incision. Another option for closing an incision is to use a surgical stapler. Mulford (1984) claims the use of staples reduces surgery time and minimizes stress on the fish. Unfortunately, no physiological or cytological data is presented to support the claim of stress reduction. The most common materials used for closing incisions in fish surgery are types of sutures, monofilament and braided silk. Non-absorbable monofilament is the material better suited for use in fish because it causes less macroscopic inflammation (Wagner *et al.*, 2000). Antibiotics may be administered before the fish is placed in a recovery tank and released following a recovery/observation period.

Transintestinal expulsion of surgically implanted acoustic tags has been seen in some species, particularly the Siluriformes. Baras and Westerloppe (1999) found that 17.6% of African catfish exhibited transintestinal expulsion of acoustic tags within 12 days post-surgery. Of the thirty-five channel catfish implanted with dummy transmitters by Summerfelt and Moser (1984) only ten retained their tags after 112 days. Marty and Summerfelt (1986) showed that tags expelled by channel catfish were first surrounded by a granulated tissue composed primarily of collagen and myofibroblasts. The encased tags would exert enough pressure on either the body wall or incision to cause expulsion of the tag. Transintestinal expulsion of tags seems to be rare, however, as the only other species reported to exhibit this phenomena are rainbow trout (Chisholm and Hubert, 1985) and bluefin trevally (Meyer and Honebrink, 2005). Few studies discuss the long-term retention of tags, perhaps due to the inability to recover tagged fish released in the wild. Tyus (1988) demonstrated that razorback sucker have a mean tag retention of one year and Colorado squawfish have a mean tag retention of 2.2 years.

The effect implanted tags have on the behavior and physiology of fishes is important to consider. If a tag alters the behavior of the fish, then a tracking study will not give a reliable picture of the fish's normal activity. One aspect that has been investigated is the swimming performance of tagged fish. Lacroix *et al.* (2004) found that tagged juvenile Atlantic salmon exhibited significantly lower critical swimming speeds in the first three days following surgery, though after one week the difference in swimming speed between tagged and control fish had been reduced to an insignificant level. Close *et al.* (2003) showed similar results with Pacific lamprey (*Lampetra tridentate*), in that swimming speed was significantly reduced in tagged fish in the first hour post-surgery, but those differences were not seen 24 and 168 hours post-surgery. Surgical insertion of tags had no affect on the swimming speeds of juvenile Chinook salmon (*Onchorhynchus tshawytscha*) (Anglea *et al.*, 2004), adult Atlantic salmon (Thorstad *et al.*, 2000), juvenile Atlantic cod (*Gadus morhua*) (Cote *et al.*, 1999) or adult westslope cutthroat trout (*Onchorhynchus clarkia lewisi*) (Zale *et al.*, 2005).

Another effect of tag implantation that has been investigated is the ability of a fish to compensate for the change in buoyancy resulting from the extra mass. Perry *et al.* (2001) used two different sizes of dummy transmitters to investigate the effect on the buoyancy compensation of juvenile Chinook salmon. The authors found that the density of the fish did not change post implantation, meaning they were able to compensate by adjusting their air bladder.

1.6 Study Background and Motivation

The research that follows is intended to further our knowledge about the behavioral ecology of blue runner in the vicinity of petroleum platforms in the Gulf of Mexico. This dissertation uses acoustic telemetry to examine the use of petroleum platforms in the South Timbalier 151 oil field (Fig. 1.2) by this pelagic fish species over a period of weeks. The research investigates whether blue runner utilize the platform complex in a different manner during the day versus the nighttime hours. In addition the research examines the movement of blue runner between the manned and unmanned platforms in an attempt to determine if there exists a difference in utilization between the platforms, possibly resulting from the more intense artificial light field provided by manned platforms. Furthermore, the schooling behavior and movement patterns of blue runner were analyzed to determine if diel differences exist in the behavior of the individuals.

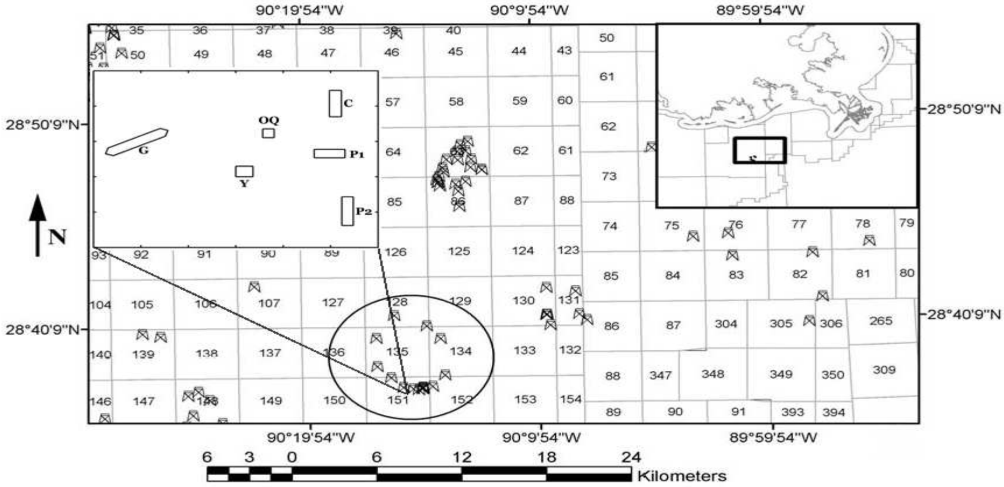

Figure 1.2. The map shows the location of the South Timbalier (ST) field in relation to the coast of Louisiana (inset top right). The area within the circle denotes the area known as “The Circle”. The inset in the upper left shows the detailed layout of the main ST151 complex – G = G-deck, OQ = Old Quarters, Y = Yankee, P1 = Production 1, and P2 = Production 2.

This remainder of this dissertation is composed of four chapters. The second chapter is the “Movement Patterns of Blue Runner (*Caranx crysos*) Around a Petroleum Platform Complex,” which includes data derived from the position solutions determined through the use of the acoustic telemetry. Chapter two investigates: (1) whether blue runner have a home range around the petroleum platforms by examining the movements of individually tagged blue runner with respect to their proximity to the platforms; (2) blue runner movement between the larger platform complex and the outlying unmanned satellite platforms in the South Timbalier oil field in the northern Gulf. .

The third chapter “Schooling Behavior of Blue Runner (*Caranx crysos*) Near Petroleum Platforms in the Gulf of Mexico,” Iuses three-dimensional positional data to address four questions related to schooling dynamics. These are: (1)to what extent do individual blue runner move between schools; (2) do blue runner school at the same frequency during both day and night; (3) how do the location of schools within the water column vary over a 24 hr period; and (4) the proximity of schools in relation to the structure of the platforms need to be addressed.

The fourth chapter is “Diel Vertical Migration Pattern of Blue Runner (*Caranx crysos*),” which examines the diel vertical migration patterns of blue runner; the physical location of tagged blue runner with respect to the manned and unmanned platforms; and whether blue runner exhibit active or passive behavior at night.

The final chapter contains a summary of the conclusions from each of the preceding chapters, tied together to discuss the overall findings and lessons learned from the research. In addition, ideas for research to further expand our knowledge of the relationship of pelagic fishes and petroleum platforms are presented.

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CHAPTER 2
MOVEMENT PATTERNS OF BLUE RUNNER (*CARANX CRYSOS*) AROUND A PETROLEUM PLATFORM COMPLEX

2.1 Introduction

2.1.1 Home Range

Historically there has been little information reported on the movements and behaviors of schooling pelagic marine fishes. This is not surprising given the technical difficulties of unobtrusively tracking highly mobile fishes in open water. One of the many questions that has not been addressed is whether schooling pelagic fishes display fidelity towards any particular area or location. Do they have a home range in the presence of hard structure such as petroleum platforms?

The home range of an organism is defined as “that area traversed by the individual in its normal activities of food gathering, mating, and caring for young. Occasional forays outside the area, perhaps exploratory in nature, should not be considered part of the home range” (Burt, 1943). To exclude the occasional trips animals make outside the normal area of activity the home range is normally considered to be area where an animal spends 95% of its time, though this definition is arbitrary and may be related to the *p*-value of 0.05 in statistical judgments (Powell, 2000). Some benefits of having a home may include increased efficiency of feeding sites, protection of favorable breeding sites and predator refugia (Kramer and Chapman, 1999). They also cautioned that by staying within their home range the animal may be forgoing the opportunity to discover higher quality habitats. A positive relationship between body size and home range size has been described for land mammals (Pagel *et al*, 1991), birds (Maurer *et al*, 1991), shrimp (Reaka, 1980) and *Cyprinella* minnows (Taylor and Gotelli, 1994). Gaston and Blackburn (1996) suggest this relationship may not be accurate, but instead may be due to using too small of a spatial scale in the research.

Most research on the home range of fishes has focused on freshwater taxa (Lowe *et al*, 2003; Lyons and Lucas, 2002), reef-associated fishes (Eristhee and Oxenford, 2001; Holland *et al*, 1996), seagrass or kelp bed-associated fishes (Jadot *et al*, 2006; Topping *et al*, 2005) or demersal fishes (Lembo *et al*, 2002; Schroepfer and Szedlmayer, 2006). Holland *et al* (1996) used acoustic telemetry to demonstrate that *Caranx melampygus* exhibited consistent diel movements within a measurable home range. Their study is the only previous research found on home range of carangids. Thus, the issue of whether or not pelagic fishes such as blue runner have a home range does not appear to have been examined. Given their frequent proximity to petroleum platforms, it would be interesting to determine whether they establish home ranges and display site fidelity and how their behavior changes near such structures.

A number of methods exist for estimating home ranges. These include gridding, minimum convex polygons, and Fourier analysis, but comparisons have shown that the most accurate method of calculating the home range is fixed kernel estimation (Borger *et al*, 2006; Seaman and Powell, 1996). The fixed kernel estimator uses location data from telemetry to create density maps across the sampling region, which can be used to determine the percent of the region used by the individual.

Three problems associated with home range estimates were outlined by Powell (2000). First, is the assumption that location data points are independent and time sequence is ignored (i.e., there is no autocorrelation of the data due to time). Second, because the estimators use a percentage of the time an animal is in a given location to determine the home range they sometimes result in oddly shaped home range outlines. Finally, the estimators only assess the probability of an individual being in a given location, but do not take into account the biological or ecological importance of that location.

Many statistical tests assume the data points are independent, but this is not the case with telemetry data as the location of an individual at any given point is dependent on the location at a previous point and autocorrelation with respect to time exists. Shorter time intervals between position fixes will lead to higher autocorrelation, meaning that points closer together in time are less independent of each other. De Solla *et al* (1999) examined the effects of autocorrelation on home range estimates and found no reduction in the validity of the estimate as long as the time interval between observations were consistent. De Solla *et al* (1999) also concluded that subsampling of data to reduce autocorrelation did not create consistently independent data sets and likely removes biologically important information. Swihart and Slade (1985) found that nonstatistical estimates of home range increase in accuracy with an increase in sample size, even if autocorrelation increases as well.

2.1.2 Objectives

The focus of this research was to investigate the movement and migration patterns of blue runner around the petroleum platforms in the Gulf of Mexico. The specific objectives were:

1. To determine if blue runner have a home range around the petroleum platforms; and
2. To determine if fish move between the manned and unmanned platforms in the Gulf of Mexico.

2.2 Methods and Study Site

2.2.1 Study Site

The study was conducted from Chevron's South Timbalier 151 (ST151) complex (28° 37.000' N, 90° 15.367' W), approximately 50 km south of Port Fourchon, Louisiana (Fig. 2.1A). The ST151 complex sits at the southern edge of a larger group of platforms known as "The Circle" which includes eleven unmanned satellite platforms and several artificial reefs over an area of about 35 km^2 (Fig. 2.1B). The complex is comprised of a series of six platforms connected by catwalks (Fig. 2.1C). Clustering of platforms is fairly common throughout the world's oceanic oil fields and numerous complexes are present in the northern Gulf. The water depth around the platforms ranges between 30–42 m. Hurricane Katrina (August 28, 2005) toppled one of the platforms in the main complex (G-Deck), and three unmanned satellite platforms within The Circle (ST135M, ST151J and ST151O).

2.2.2 Hydrophone Placement 2005

To help determine the best possible placement of the hydrophones and to determine if ambient noise would effect tag detection, an acoustic characterization and range testing survey was performed at the ST151 main complex on August 5 – 6, 2004 (Appendix A). The goal of the hydrophone placement configuration was to provide the most thorough coverage possible of the entire area within the ST151 main complex and to maximize the amount of coverage on the periphery of the complex.

On July 29 – August 1, 2005 eight underwater hydrophones (LHP-1, Lotek Wireless) were installed by divers around the ST151 main complex (Fig. 2.1D). The hydrophones were mounted on PVC brackets suspended via tensioned 6.35 mm stainless steel cables. Hydrophone depths varied between 5 and 15 m. The hydrophones were connected by a rugged marine cable, run along the stairwells and catwalks, to a Lotek MAP_600 receiver located on the Old Quarters platform. The MAP_600 system allows the simultaneous use of up to eight hydrophones to calculate two- and three-dimensional positions of tagged fish.

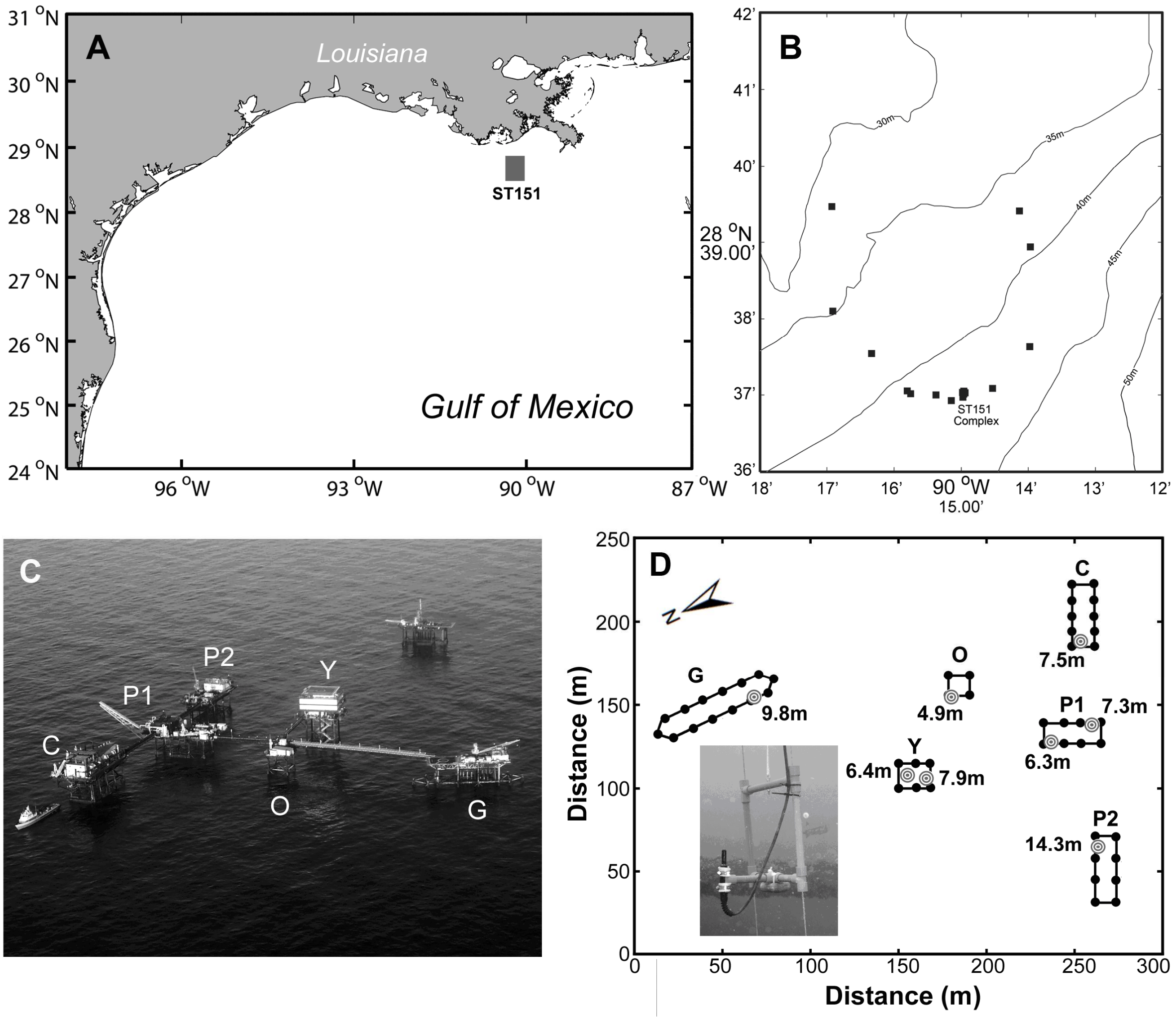

Figure 2.1. A) Location of the study site (shaded rectangle) in relation to northern Gulf of Mexico. B) The ST151 complex is located on the southern edge of a ring of unmanned platforms. C) An aerial photo of the complex viewed from the north. G=G-Deck, O=Old Quarters, Y=Yankee, C=Compressor, P1=Production One, P2=Production Two. D) The six platforms that make up ST151 with their pilings indicated in black circles. The locations of the eight hydrophones indicated by (◎) that were linked to a receiver on Old Quarters. Hydrophone depths are indicated next to each location.

To determine the two-dimensional position of a tagged animal, a pulse must be received by at least three fixed hydrophones in an array. As summarized in section 2.1.3, the differences in arrival times of the transmit pulse can be used to compute a hyperbolic line of constant time delay between the pairs of hydrophones. The position of the tag is then calculated by the intersections of two or more time-delay hyperbolae. The more hydrophones in the array that receive the signal the more precise the determination of the tagged animal's position may be.

Testing of the MAP_600 system was conducted on August 2, 2005. An acoustic tag was lowered to the bottom of the water column (approximately 40 m) and incrementally raised at one minute intervals until the tag reached the surface and was retrieved. This test was performed at thirty locations around the ST151 complex to determine if the signal could be received throughout the complex. Testing showed that reception was stronger (more hydrophones received the signal) at the surface than at the deeper depths (Fig. 2.2).

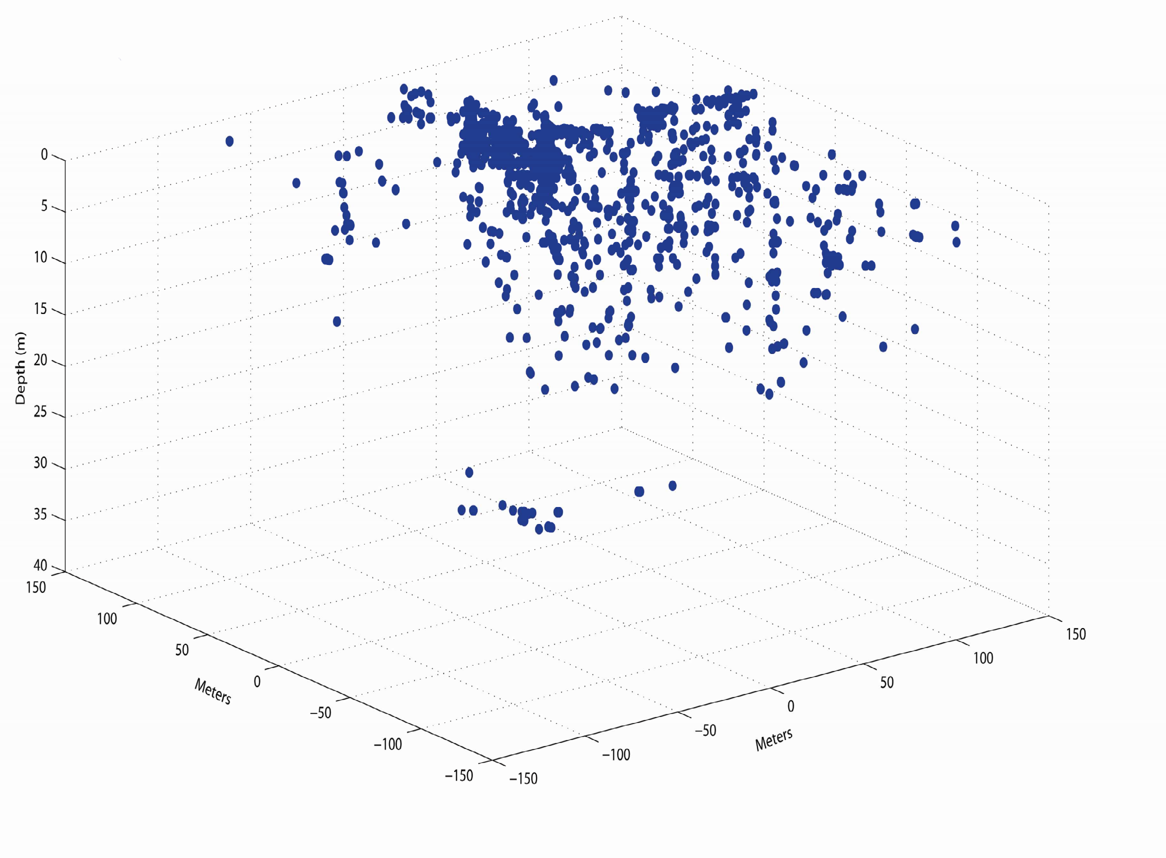

Figure 2.2. A three dimensional plot showing receptions of tags during testing in August 2005.

The MAP600 was set to receive at 76kHz. The system was operational for 23 days (August 5 - 27, 2005) but the study had to be terminated prematurely due to the impending arrival of Hurricane Katrina. During operation, the system recorded detections continuously except for a brief five to ten minute interval each morning when data were transferred from flash memory in the receiver to a laptop.

In addition to the hydrophones on the main complex, six unmanned platforms were scheduled to have a hydrophone and a MAP_RT receiver installed. Chevron installed solar panels and battery boxes on each platform to power the receivers (Fig. 2.3). One of the platforms (151W) could not be used due to ongoing drilling operations. Time and weather constraints only allowed for the installation of hydrophones on four of the five remaining unmanned platforms (134S, 135M, 151I and 151K). Unfortunately, the solar panel/battery box power system on 151I malfunctioned and was unable to supply power to the MAP_RT receiver, leaving three monitored, unmanned platforms. All three MAP_RT receivers began collecting data on August 11, 2005. The MAP_RT receivers were shut down and data collection ended at the unmanned platforms on August 26, 2005.

Figure 2.3. The solar panel array installed on 135M used to supply power for the MAP_RT receiver (Photo by M. Benfield).

2.2.3 Hydrophone Placement 2006

Due to the damage caused to the platform complex by Hurricane Katrina, I was unable to use the cabled MAP_600 system during 2006. Instead Lotek Wireless WHS_3050 submersible data loggers were used. The WHS_3050 is a self-contained hydrophone system containing a battery, data storage flash memory and hydrophone receiver (Fig. 2.4). The WHS_3050 does not permit two-dimensional localization of tagged fish, but it does allow for presence/absence detection of fish and can log the depth and temperature data transmitted by tags. The WHS_3050s were programmed to record for 90 seconds and sleep for 60 seconds. This duty cycle allowed for approximately 60 days of battery life.

Figure 2.4. WHS-3050 with mounting bracket before being deployed.

On August 14 – 15, 2006 nine WHS_3050s were deployed on the legs of platforms around the main complex and "The Circle", while a tenth WHS_3050 was deployed on August 21, 2006 (Table 2.1). The original plan was to deploy five hydrophones around the main complex and five on unmanned platforms. Unfortunately, one of the unmanned platforms was unsafe for diving operations due to damage caused by Hurricane Katrina and salvage operations were being performed on a second unmanned platform, therefore only three unmanned platforms were available for hydrophone deployment. A total of seven hydrophones were deployed around the ST151 main complex (Fig. 2.5). Two hydrophones were deployed at ST151 Production 1 and at ST151 Production 2. The remaining three hydrophones were deployed at unmanned platforms: ST128R, ST151K and ST152P (Fig. 2.6).

The hydrophones on ST151 Production 1 were recovered on September 20, 2006 and the remaining eight hydrophones were recovered on November 1, 2006. The hydrophone deployed at 8.2 m on ST151 Production 1 worked intermittently, leaving gaps in the data. The hydrophone deployed at ST152 Poppa leaked and all electronics were damaged; therefore, no data was retrieved from that hydrophone.

Table 2.1. Locations, deployment dates and depths of WHS_3050 submersible data loggers deployed at study site in 2006.

Location	Deployment Date	Deployment Depth (m)
ST 151 Production 1	August 14, 2006	8.2
ST151 Production 1	August 21, 2006	19.8
ST151 Production 2	August 14, 2006	14.6
ST151 Production 2	August 14, 2006	14.9
ST151 Yankee	August 15, 2006	10.7
ST151 Compressor	August 14, 2006	12.2
ST151 Old Quarters	August 14, 2006	7.6
ST128 Romeo	August 15, 2006	14.3
ST151 Kilo	August 15, 2006	8.2
ST152 Poppa	August 14, 2006	15.5

2.2.4 Acoustic Tags 2005

Small, cylindrical acoustic tags (CTP_M11_12, Lotek Wireless) that were 11 mm in diameter and 46 mm long with a mass of 8.2 g in air were used for this project. Each tag transmitted an encoded identity number over a frequency of 76 kHz. Thirty-five tags were set to transmit at four-second intervals (0.25 Hz) and fifteen tags were set to transmit at two-second intervals (0.5 Hz). The expected lifespans of the tags at these two transmit rates were 30 and 10 days, respectively. All tags were equipped with temperature and pressure sensors and these data were transmitted on alternate pings along with the identity number.

All individual tags were tested from the Old Quarters platform by placing five tags at a time in a mesh dive bag and lowering them into the water column to a depth of approximately ten meters. The tags were held at depth until they began to register on the MAPHOST software on the laptop computer connected to the MAP_600 receiver. MAPHOST is a software package provided by LOTEK Wireless which allows the user to turn the MAP_600 and MAP_RT receivers on an off and also allows for real time viewing of tag receptions. Two tags were inoperable and one tag was found to have a faulty depth sensor. These three tags were not used in this research.

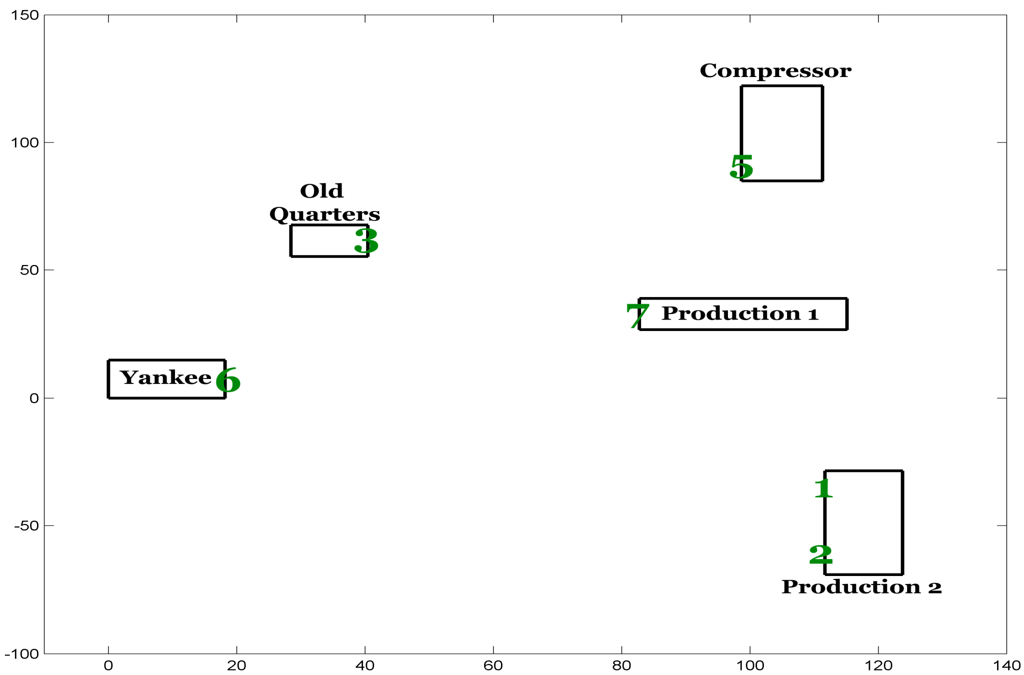

Figure 2.5. Location of deployed hydrophones at the ST151 main complex in 2006. Two hydrophones were mounted on Production 1 platform, one above the other.

2.2.5 Acoustic Tags 2006

As in 2005 the CTP_M11_12 (Lotek Wireless) acoustic tags were used. Fifty tags were set to transmit at ten-second intervals (0.1 Hz) with an expected lifespan of 90 days. All tags were equipped with temperature and pressure sensors and these data were transmitted on alternate pings along with the identity number.

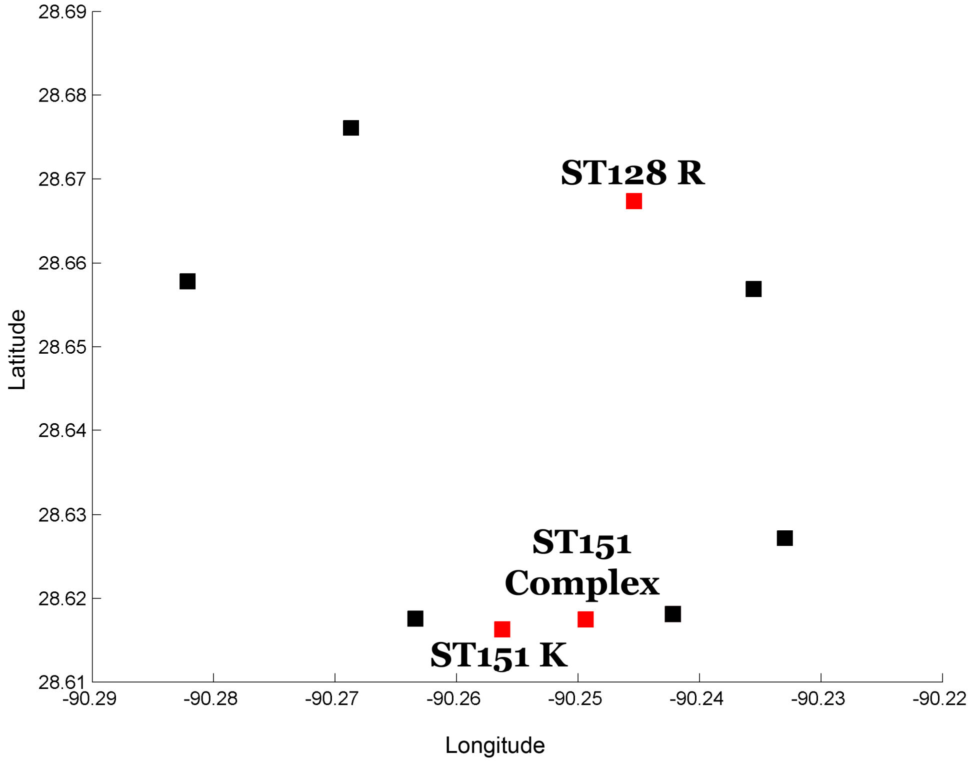

Figure 2.6. Location of unmanned platforms with hydrophones, relative to the location of the main complex in 2006.

2.2.6 Surgical Implantation of Tags

Fish were collected using barbless lures to minimize the physical damage to the fish. All fishing and surgeries were done from the Old Quarters platform in 2005. In 2006 all fishing and surgeries were conducted from a chartered sport fishing vessel (M/V Different Drummer). In 2005, fishing operations began in the mornings at about 0800 and continued until about 1030. Blue runner became very difficult to catch at about that time each day until around 1400 – 1430. At that time fishing would resume until approximately 1730. The fish used were generally greater than 400g in mass, which was equivalent to a maximum of 5% tag weight to body weight.

Once captured the fish were placed in an aerated tank of ambient sea water and then transferred into a cooler containing an 80-ppm solution of tricaine methane sulfonate (MS-222) until completely anesthetized. The optimum concentration of MS-222 was experimentally-determined during a pilot study (Appendix B). Once anesthetized, the fish were weighed to the nearest gram and their fork length (FL) was measured to the nearest millimeter. Fish were then placed ventral side up on the surgical table fitted with wet foam while a 50-ppm solution of MS-222 and oxygenated sea water was pumped through their mouth and over the gills. The area between and around the pelvic fins and the anus was swabbed with betadine and a small incision was made posterior to the pelvic fins using a scalpel. A sterile acoustic tag was inserted anteriorly into the peritoneal cavity of the fish (Fig. 2.7). The incision was then sutured shut. Following implantation, 1 ml of a broad spectrum antibiotic (oxytetracycline 1000 mg ml^{-1}) was injected intramuscularly and the sutured wound site was swabbed with triple antibiotic ointment. Each fish was then placed in a holding tank containing oxygenated sea water until it recovered equilibrium. For a more complete discussion of the surgical protocol see Appendix C.

Following surgery, each fish was transferred to a holding pen suspended beneath the Yankee platform for an 8 h observation period before release. All fish in the holding pen were released as a group each morning. This release method was used in an effort to decrease the likelihood that a fish would be attacked by a predator immediately upon release. No fish died or appeared to be in distress after 8 h in the holding pen. Between August 5-15, 2005, 33 blue runner with 4-second tags and 13 with 2-second tags were released.

Figure 2.7. Picture showing the location and orientation of an acoustical tag inserted in to a *Caranx crysos* that did not survive the surgery and was dissected. (Photo by S Keenan).

In 2006 the implantation of tags took place during August 21-24, 26 and September 20. Weights of all fish could not be measured due to damage to the scale used in the research. Fish weights were estimated from a length to mass relationship calculated from a sample of 80 fish collected during tagging. A total of 19 blue runner were caught and tagged during this period. All fish were tagged with 10-second ping rate tags.

In 2006 recovering fish were placed in a holding tank on the deck of the boat. These fish were observed for at least two hours before being released. The shorter period of holding time was necessary because vessel motion caused the water in the holding tank to slosh back and forth, which could potentially injure the fish. None of the fish that were released appeared to be in distress while in the holding tank.

Eighty fish were caught using hook and line on September 20, 2006 to measure the length: mass relationship. The fish were immediately placed on ice and at the end of the cruise transported to the lab where they were stored in a freezer until they could be measured. The fish were weighed to the nearest tenth of a gram and fork length, standard length and total length were all measured to the nearest millimeter. Linear regressions were calculated comparing mass of each fish to its fork length, standard length and total length.

2.2.7 Data Analysis

The telemetry data were imported into BioMAP software (Lotek Wireless) for processing. BioMAP performs the localization of the tag transmission data recorded by the MAP_600 system to estimate the 2D positioning of the tagged fish. Although the system provides 2D estimates, the true location of each fish includes a depth component. The impact of ignoring the depth of the fish when estimating its location within the detection envelope is small. For a fish located at the greatest distance from our hydrophones (approximately 300 m), the positional error would be ±0.16 m during the day (assuming 10 m depth) and ±1.04 m at night (assuming 25 m depth). For fishes closer to the array or shallower than these depths, the errors would be smaller.

The BioMAP software also contains a database tool, which allows for the filtering of the data for analysis. Three metrics are provided through BioMAP to help determine the reliability and accuracy of the positioning data. Condition number is a measure of the mathematical stability of the inverse of the matrix used to determine the position solution. Reliability number and dilution of precision are indicators of degrees of freedom and accuracy, respectively, for the positioning solution. These metrics were used to filter the 2D positioning data to eliminate outliers. Subsequently a fourth filter was based on maximum likely swimming velocity. Consecutive data points that represented a swimming velocity greater than 20 body lengths s^{-1} were eliminated because this velocity was deemed to be physiologically unlikely based on a review of published burst swimming velocities of a variety of different species (See Appendix D). Only fish that were tracked for a minimum of seven days were included in the analysis. This eliminated fish that may not have fully recovered from the surgical tag implantation and allowed time for the fish to return to their normal behavior patterns.

Filtered data were imported into ArcMap 9.2 (ESRI) where the home range was calculated using the Home Range Extension. Fixed kernel home range estimation was calculated using least squares cross validation (Worton, 1989). The areas of the 50% and 95% ranges were estimated. Pearson's product moment correlation was calculated using the fork length and size of the overall and mean daily ranges using MATLAB.

Data were examined for differences between the daytime and nighttime home ranges. Day encompassed local sunrise + 30 min to local sunset – 30 min, whereas night encompassed sunset + 30 min to sunrise – 30 min. Sunrise and sunset times at ST151 were obtained from the US Naval Observatory. Differences in the sizes of the daytime and nighttime ranges were tested for normality (Jarque-Bera test, Jarque and Bera 1980) and for homogeneity of variance using an F-test in MATLAB. If the data were both normally distributed and showed homogeneity of variance, then a two-tailed paired t-test (α=0.05) was run to test for differences in size of the home range, otherwise a Mann-Whitney U test (α=0.05) was run using the Statistics for Research and Analysis Software Package (SPSS), (SPSS Inc., Chicago, IL). The successive day/night samples for individual fish were used as replicates for the paired t – or Mann_Whitney U-tests. A general linear model was run to compare the sizes of the day and night home range areas at the population level for all tagged fish using SPSS. A multivariate general linear model was performed using SPSS to compare the areas of the daily home ranges at the population level for all tagged fishes by the categorical variables individual fish and Julian date, with an interaction term included (Zar, 1995).

2.3 Results

2.3.1 Tagged Fish (2005)

Of the 46 *Caranx crysos* released with acoustic tags, 23 were tracked for at least seven consecutive days (Fig. 2.8, Table 2.2). Consecutive days refers to at least one valid position solution obtained in a 24 h period, although in almost all cases the number of valid position solutions obtained in a 24 h period was much greater than one. Home range analyses were restricted to these 23 individuals, ranging in size from 267 - 338 mm FL and 397 – 747 g (Table 2.2).

All blue runner were tracked daily over a continuous period, except fish 32700, which disappeared on August 18 and returned on August 25, fish 33000, which was not located on August 16, 19, and 21-22, and fish 34300, which was not located on August 15-17 and August 19-22. Nine of the fish (30200, 30500, 30600, 32500, 32700, 33000, 33700, 34200, 34300) were not tracked during some nights, but would return the next day. The number of localizations was fewer during the night hours versus the day hours (Fig. 2.9). Overall the number of times an individual fish was located at the platforms during the day versus the night was significantly higher for all but five of the tagged fish based on t-test (α=0.05).

2.3.2 Home Range

The mean size ($\pm$ standard error) of the core (i.e. 50%) home range was 2,352 ($\pm$225) m^2 for all twenty-three fish over the entire study period, with a range of 652 – 5,307 m^2. The mean size ($\pm$ standard error) of the 95% range was 21,204 ($\pm$ 1,491) m^2, with a range of 10,246 – 36,406 m^2 (Fig. 2.10). There was a significant correlation between the fork length of the fish and the size of their core ranges, however, there was no significant correlation between fork length and their 95% ranges (Table 2.3).

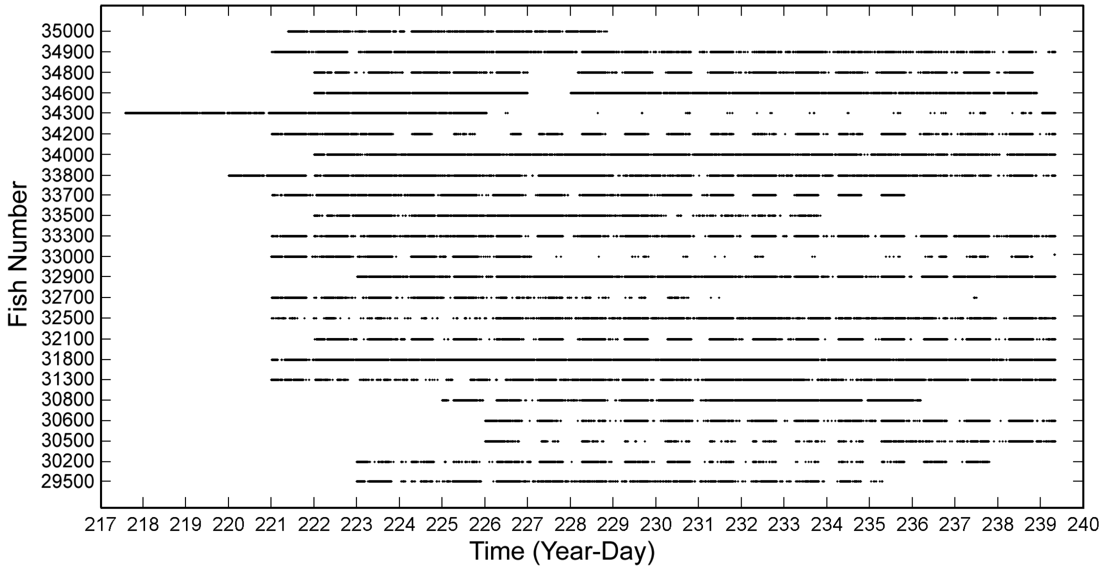

Figure 2.8. Periods when each of the 23 individual blue runner from this were localized over the duration of this study.

When overall home ranges were broken down into 24-h periods (daily ranges) the mean core daily range of individual fish varied from 373 – 2,202 m^2 while the corresponding mean 95% daily range was between 3,082 – 14,333 m^2 (e.g. Fig. 2.11). There was no correlation between the fork length of the fish and the average size of their daily core home ranges, but there was a correlation between the fork length of the fish and the average size of their 95% daily range (Table 2.3). A general linear model revealed a significant difference between the size of the core range and the 95% range when comparing both the Julian day and the individual fish (Table 2.3). This indicates that the size of the ranges increased over time and that the home range areas for all tagged blue runner within the population varied significantly day to day over the course of the study.

Some of the fish showed limited site fidelity for one or more platforms within the complex. There were three general patterns of site fidelity: fish that frequently restricted their core home range to the area around the same platform in the complex over seven or more days (e.g. Figs. 2.12A, B); fish that remained at the same structure (i.e. platforms) for shorter periods of at least 3 – 6 consecutive days (e.g. Fig. 2.12C); and a few fish that changed the location of their core home range from day to day (e.g. Fig. 2.12D). Of the 23 fish studied here, eleven repeatedly located their core range beneath the same region of the platform complex for at least seven consecutive days. Nine fish demonstrated site fidelity to particular platforms for periods of 3 days. Only three fish showed no site fidelity and the centroid of their core range was not located at one platform on successive days. Fish 30200 provides an example of consistent site fidelity around the Yankee platform over ten days (Aug 14 – 23) (Fig. 2.12).

Table 2.2. Identity codes, fork length, mass and the maximum consecutive days at liberty of 46 tagged blue runner that were tracked around ST151 in August 2005.

Code	***Fork Length (mm)***	***Mass (g)***	***Days Tracked***	***Code***	***Fork Length (mm)***	***Mass (g)***	***Days Tracked***
29500	282	407	13	32300	298	413	5
29600	279	387	3	32400	278	392	3
29800	281	390	1	32500	298	455	20
29900	289	432	6	32600	284	418	2
30000	281	398	2	32700	267	397	18
30100	291	401	2	32800	304	448	3
30200	294	442	16	32900	300	442	18
30300	304	403	1	33000	293	400	19
30400	295	442	2	33200	281	406	5
30500	299	462	15	33300	291	407	20
30600	286	405	15	33500	278	486	13
30700	321	480	2	33600	318	562	4
30800	304	403	13	33700	275	392	16
31200	288	413	6	33800	290	390	21
31300	338	624	20	34000	375	747	19
31400	298	425	5	34100	311	560	3
31500	297	458	5	34200	283	408	20
31600	282	421	5	34300	285	375	23
31800	316	482	20	34500	318	527	2
31900	261	381	2	34600	303	527	18
32000	296	493	6	34800	283	392	18
32100	288	493	18	34900	293	401	20
32200	335	614	2	35000	301	469	8

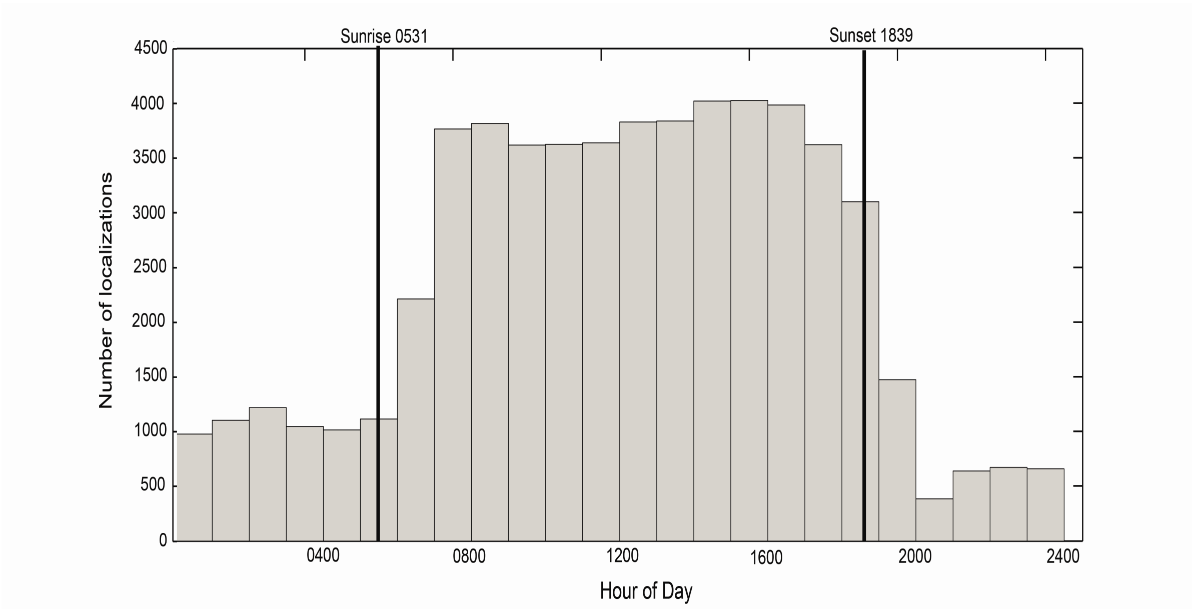

Figure 2.9. The cumulative number of localizations during the entire study period (August 5 – 27, 2005) broken down by one hour periods. The lines bisecting the histogram indicate sunrise and sunset times on August 16, 2007 (the middle of the study period).

Table 2.3. Results of the test of correlation between home range size and fish fork length (FL) and the general liner model rest comparing home range size by Julian date and individual fish.

Correlations	**r**	**p**	**n**
FL and 50% range over entire study	0.471	0.023	23
FL and 95% range over entire study	0.321	0.135	23
FL and mean size of daily 50% range	0.393	0.064	23
FL and mean size of daily 95% range	0.524	0.010	23
General Linear Model	$\mathbf{R^2}$	**F**	**p**
50% range	0.163	-----	-----
95% range	0.231	-----	-----
Julian day versus 50% range	-----	14.273	0.000
Julian day versus 95% range	-----	20.476	0.000
Individual fish versus 50% range	-----	2.681	0.000
Individual fish versus 95% range	-----	4.085	0.000

Within the complex, the core home ranges of different fish, each displaying evidence of high site fidelity were not spatially collocated at the same part of the platform on the same days, even though each appeared to favor a specific location in the complex. Visual observations of blue runner schools around the complex suggested that there were many different concurrent schools around the complex. Although the core home ranges of some tagged fish overlapped on some days, daily differences in the locations of their core home ranges over the course of the study suggest that individual membership in schools varied over time.

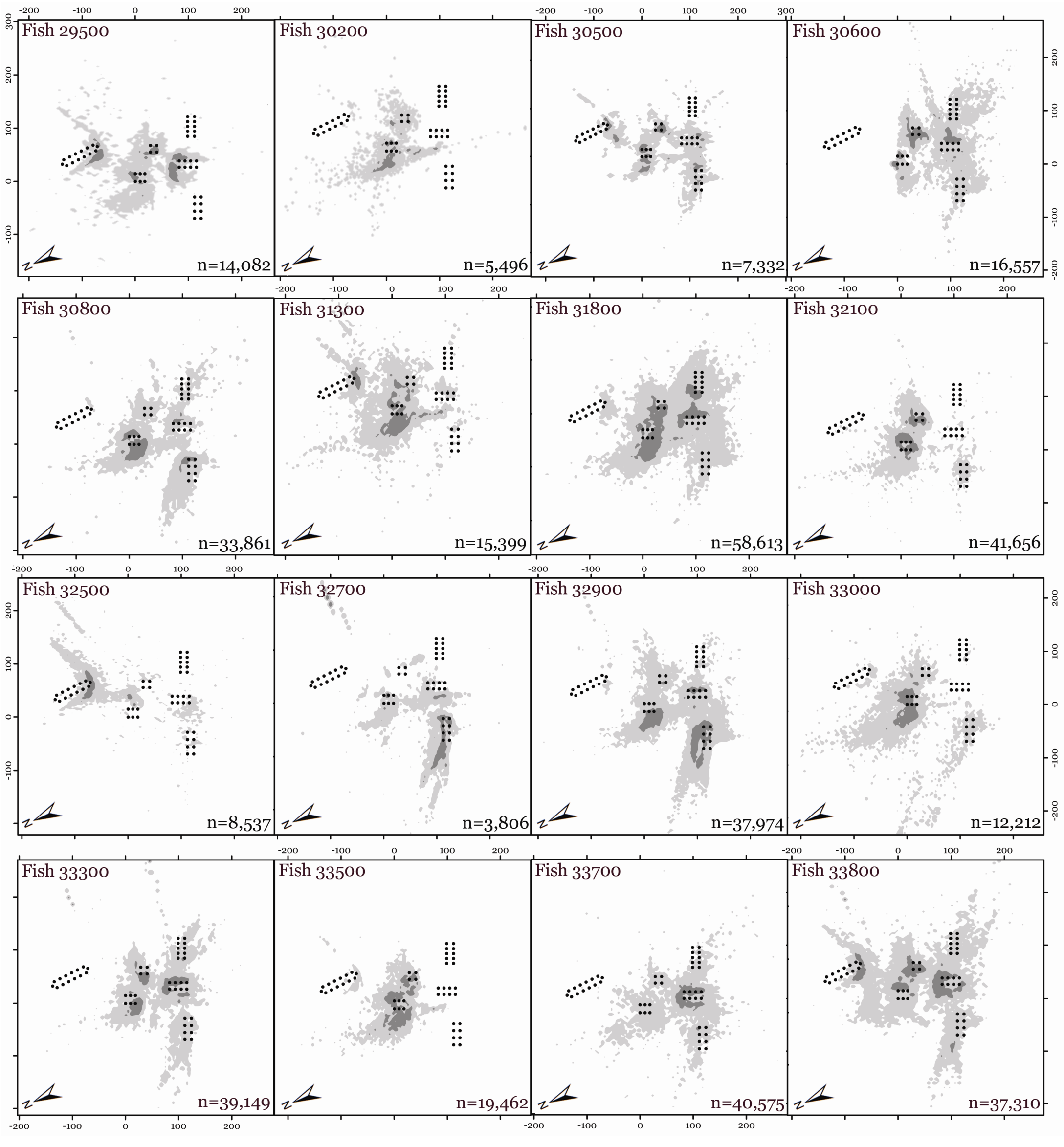

Figure 2.10. The overall home range of tagged blue runner over the entire study period (August 5-27, 2005). The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

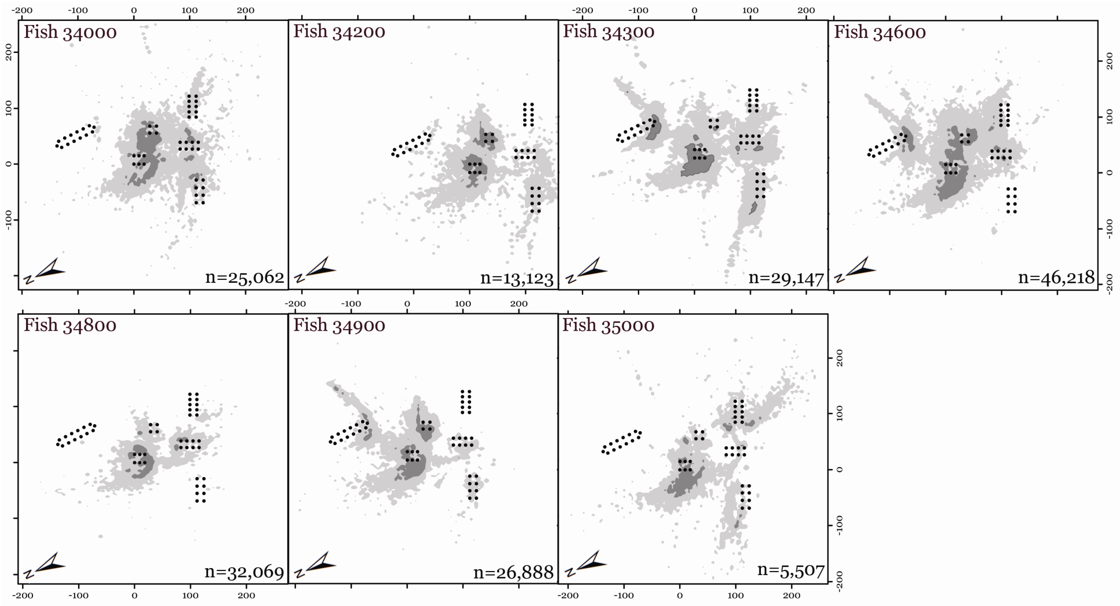

Figure 2.10 (continued)

Core and 95% home ranges were generally larger during the day and smaller at night. The mean daytime core range was between 404 – 2,311 m^2 and the mean nighttime core range was between 231 –1,744 m^2 (e.g Fig 2.13, See Appendix E for all day/night plots). Seven fish displayed significant differences between the sizes of their day and night core ranges (Table 2.4). The mean daytime 95% range was between 3,034 – 13,722 m^2 and the mean night 95% range was between 1,299 and 9,182 m^2. Seven fish had significant differences in the sizes of their day and night 95% home ranges (Table 2.4). The overall differences in core range and 95% range when comparing day and night were both significantly different (Table 2.4). The differences in the sizes of the home ranges of the population of tagged fish tested using multivariate GLM were explained by the variables used (fish ID and Julian date) with low, but significant coefficients of determination (Table 2.4), with home range areas increasing over time.

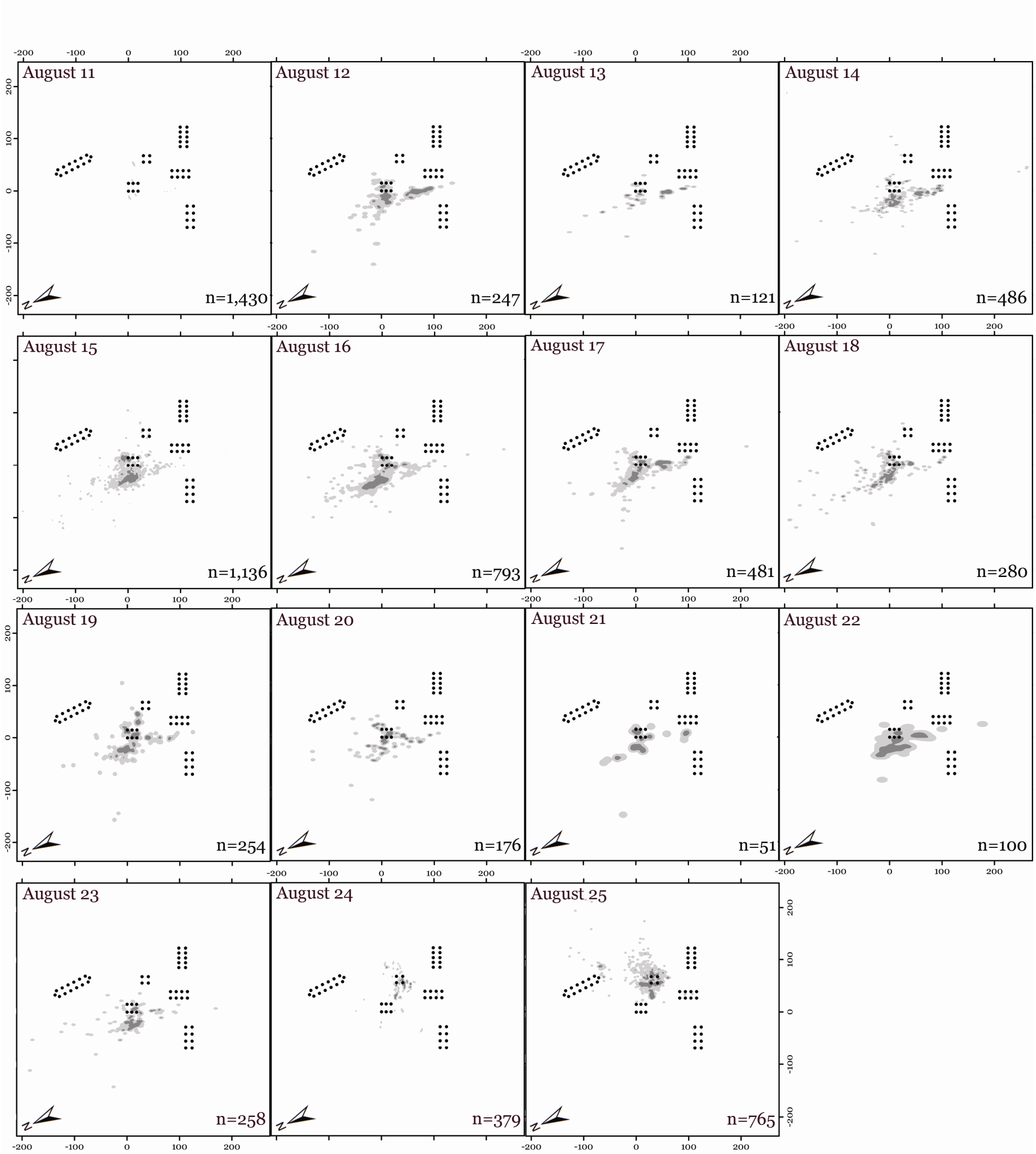

Figure 2.11. The home range of tagged Fish 30200 over the period of August 11 - 25, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

2.3.3 Morphometrics

The fish used in the length: mass calculations varied in size with standard length varying between 150 - 292 mm, fork length varying between 158 - 299 mm, total length varying between 185 - 363 mm, and mass varying between 65.4 - 478.9 grams. No determination of sex was made for any of the fish used for the morphometric calculations.

The regressions calculated were as follows:

TL = 0.3759 * Mass(g) + 175.89 (R^2=0.99)

SL = 0.2941 * Mass(g) + 142.25 (R^2=0.98)

FL = 0.2998 * Mass(g) + 150.98 (R^2=0.97)

SL = 1.2734TL – 4.8885 (R^2=0.99)

SL = 1.0205FL + 5.729 (R^2=0.99)

FL = 1.2335TL – 8.7716 (R^2=0.98)

2.3.4 Broad Scale Movement

The broad scale movement of blue runner was determined using the data from the WHS-3050 hydrophones deployed in the August 2006. A total of nineteen blue runner were tagged during the 2006 study period (Table 2.3). Of these only nine were detected long enough to be monitored.

Four of the fish were caught and released at ST151K. One of those (Fish 30900) remained at ST151K for fifteen days, after which no detections of that fish were made (Fig. 2.13A). The remaining three stayed at ST151K for a period before moving to the main complex. Fish 34800 remained at ST151K for seventeen days before moving to the main complex where it remained for at least twenty-four days, when no further detections were made.

Fish 34900 remained at ST151K for six days before moving to the main complex where it remained for at least fourteen days when no further detections were made. Fish 35100 remained at ST151K for sixteen days before moving to the main complex for at least thirty-two days when no further detections were made (Fig. 2.13B).

Three fish were caught at ST151K and released at the main complex. No detections were made of any of these fish other than at the main complex. Fish 35300 remained at the main complex from the time of its release until no further detections were made comprising a total of fifty days. Fish 35500 remained at the main complex for a total of forty-seven days. Fish 35600 remained at the main complex for a total of thirteen days before no further detections were made (Fig. 2.13C).

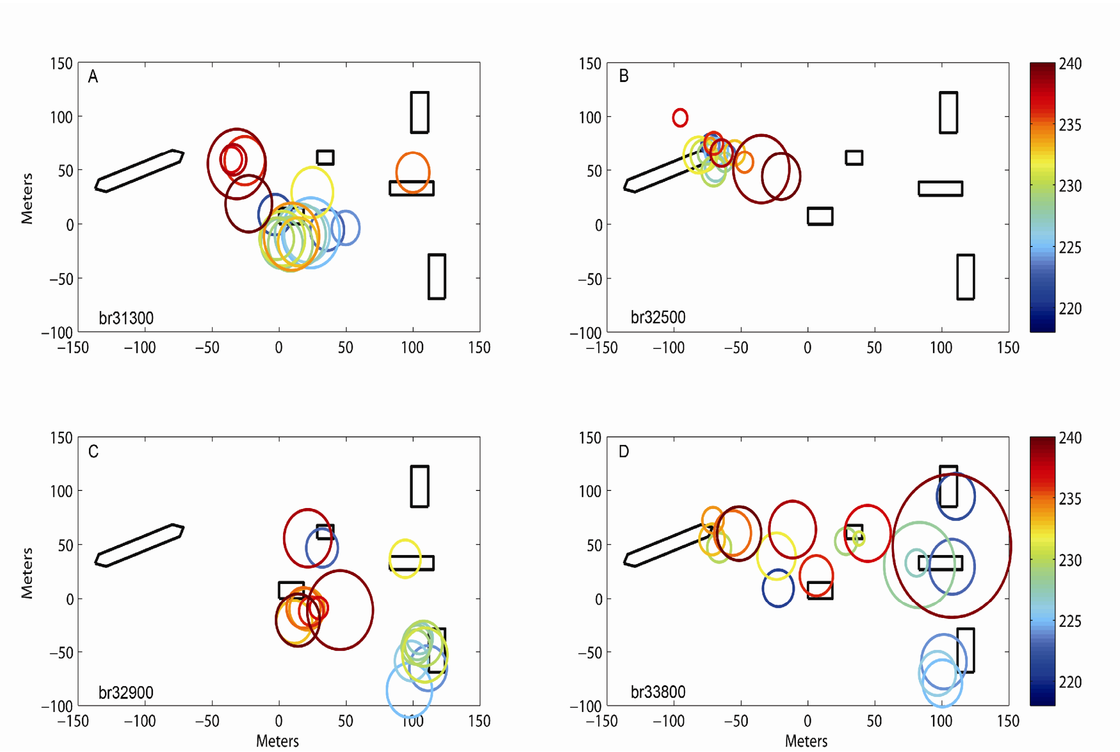

Figure 2.12. Each circle represents the location and size of the daily core range of a particular fish over the length of the study period. The colors of the circles indicate yearday. A) Fish 31300 showed a preference for Yankee platform. B) Fish 32500 showed a preference for G-Deck. C) Fish 32900 originally showed a preference for Production 2 platform then moved on to Yankee platform. D) Fish 33800 showed no consistent preference for any particular platform.

2.4 Discussion

Acoustic telemetry allowed for simultaneous localization of the positions of 46 tagged *Caranx crysos* with high temporal resolution for up to a month during 2005. These localizations enabled the movement patterns of fish to be evaluated within a large area (5.62 hectares) encompassing six interconnected petroleum platforms in the Gulf of Mexico. Twenty three of the tagged fish were localized with sufficient consistency that their site fidelities and home ranges could be measured using fixed kernel analysis. In 2006 nine *C. crysos* were tracked for almost 60 days. The tracking data enabled large scale movements of fish to be evaluated over an area of about 35 km^2 encompassing thirteen petroleum platforms in the Gulf of Mexico. The results suggest that pelagic *C. crysos* demonstrate limited site fidelity and have measurable home ranges while in the proximity of artificial structure. This research provides new information regarding the use of artificial habitats by a marine pelagic fish.

Table 2.3. A listing of the blue runner tagged and released for monitoring in 2006. The table shows the date the fish was caught and surgically implanted with an acoustical tag and the fork length (mm) of the fish. Refer to Figure 13 for locations of capture and release sites.

Date Collected	***Tag ID Number***	***Fork Length (mm)***	***Collection Location***	***Release Location***
August 21	30900	345	ST151K	ST151K
August 21	34700	318	ST151K	ST151K
August 21	34800	329	ST151K	ST151K
August 21	34900	330	ST151K	ST151K
August 21	35000	296	ST151K	ST151K
August 21	35100	321	ST151K	ST151K
August 21	35300	340	ST151K	ST151 Complex
August 21	35500	317	ST151K	ST151 Complex
August 21	35600	323	ST151K	ST151 Complex
August 22	35900	281	ST151 Complex	ST151 Complex
August 22	35700	328	ST151 Complex	ST151 Complex
August 22	36100	272	ST151 Complex	ST151 Complex
August 22	36400	311	ST134W	ST151 Complex
August 22	36500	316	ST134W	ST151 Complex
August 24	36600	292	ST151K	ST151 Complex
August 24	36700	286	ST151K	ST151 Complex
August 24	37000	298	ST151K	ST151 Complex
August 24	36800	262	ST151K	ST151 Complex
August 24	36900	271	ST151K	ST151 Complex

Table 2.4. Results of the paired t-tests and Mann-Whitney U tests to compare the day and night home range sizes of individual fish and the multivariate general linear model comparing day and night home range sizes by Julian date and individual fish.

Paired t/M-W U	**50% range**			**95% range**		
Fish ID	**t/U**	**P**		**t/U**	**P**	
29500	50	0.137		46	0.087	
30200	64	0.567		75	0.721	
30500	1.212	0.292		1.378	0.240	
30600	63	0.649		2.118	0.060	
30800	0.753	0.469		49	0.316	
31300	92	0.045		76	0.006	
31800	79	0.008		62	0.001	
32100	129	0.610		89	0.057	
32500	99	0.126		75	0.017	
32700	0.010	0.992		0.891	0.402	
32900	76	0.051		89	0.142	
33000	20	0.046		16	0.019	
33300	135	0.393		122	0.206	
33500	36	0.039		36	0.039	
33700	87	0.451		89	0.505	
33800	107	0.032		93	0.010	
34000	126	0.540		97	0.106	
34200	89	0.421		65	0.072	
34300	0.099	0.924		0.723	0.490	
34600	71	0.032		76	0.051	
34800	131	0.658		60	0.003	
34900	1.987	0.063		3.437	0.003	
35000	-0.63	0.952		21	0.279	
Multivariate GLM	**50% range**			**95% Range**		
	R^2	**F**	**p**	**R^2**	**F**	**p**
Model results	0.183	-----	-----	0.232	-----	-----
Julian Date	-----	3.557	0.030	-----	4.268	0.015
Individual Fish	-----	1.795	0.002	-----	2.354	0.000

2.4.1 Home Range

Caranx crysos were closely associated with the petroleum platform complex. While blue runner may make short excursions away from the complex, the majority of the individuals routinely returned to the platforms and no long range movement was detected. For example, sentinel hydrophones sited at three outlying platforms several kilometers away from ST151 never detected the presence of fish tagged and released at ST151. This suggests that the main platform complex appears to be a preferable habitat for the blue runner during the study period. On the other hand, given the number of fish tagged, it is also possible that there were too few fish to adequately detect movements from the main complex to other satellite platforms or that the satellite platforms where our receivers were placed, did not constitute preferred sites for blue runner. The consistency of detection records at the main complex do support the hypothesis that the main complex is more prominently selected by blue runner over the outlying satellite platforms.

Some of the fish exhibited site fidelity for the same platform within the complex on consecutive days, though the particular platform varied from fish to fish. This suggests that each of these fish may have elected a particular location persisted for days to a week. Maintaining a particular home range or territory is common when fish must defend a nesting (e.g. Lissaker and Kvarnemo, 2006) or mating site (e.g. Warner and Schultz, 1992). There are several possible explanations for why blue runner may show an affinity for the platform complex in general. Blue runner are reproductively active during the summer months (Goodwin and Finucane, 1985, McKenney *et al*, 1958) and they may utilize the platforms as a mating site. Proximity to the platforms may permit access to elevated concentrations of planktonic food supplies, particularly at night when platform lights likely permit foraging at night through the upper half of the water column (Keenan *et al*, 2007). A third factor explaining their affinity for the complex may be that the three-dimensional structure of the platforms provides refuge from larger predators. Visual observations indicate that when threatened, blue runner will temporarily disperse from the school and quickly move into the structure beneath the platforms. These factors could all explain why blue runner associate with platforms in general, however, none of them adequately explains why individual fish had home ranges that encompassed the same regions of the complex for several days at a time. This issue certainly merits further study.

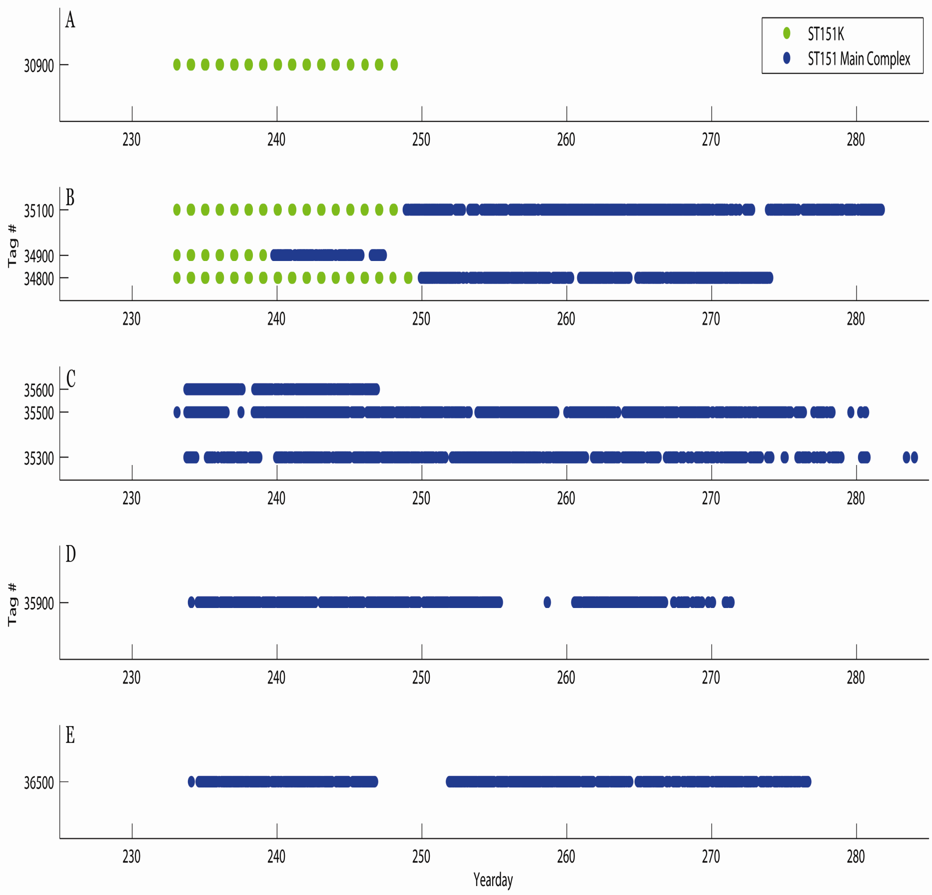

Figure 2.13. Each circle in the plots indicate one detection of a tagged fish. A) Fish caught and released at ST151K which remained at ST151K, B) Fish caught and released at ST151K which moved to another platform, C) Fish caught at ST151K and released at the main complex, D) Fish caught and released at the main complex, E) Fish caught at ST134W and released at the main complex.

2.4.2 Spatial Movements

The movements of *Caranx crysos* have essentially been treated in a two dimensional context. In fact pressure data indicates that while blue runner are typically located near the surface during the day, they exhibit a reverse vertical migration to 20 –

25 m at night with an ascent at dawn. When fish migrate down through the pycnocline (density gradient), it is likely that fewer transmissions from their tags are received at the hydrophones located in the upper water column. The pycnocline acts as a partial physical barrier to sound propagation. This would explain why fewer transmission events were detected during the nighttime relative to the day.

A positive relationship between body size and home range size has been described for land mammals (Pagel *et al*, 1991), birds (Maurer *et al*, 1991), shrimp (Reaka, 1980) and *Cyprinella* minnows (Taylor and Gotelli, 1994). The basis for this relationship is that larger animals have greater mobility than smaller ones. The present study's data provided mixed results with regards to the relationship with positive correlation between the overall core range and the 95% daily range and the fork length of the fishes, but no correlation between the overall 95% range and the average daily core ranges and the fork length of the fishes. However, the size range of the tagged fish in this study were relatively narrow and a larger size range may provide more information with respect to this question.

The home ranges of all tagged fish on a particular Julian day were not significantly different among days, though the multiple regression analyses do indicate a trend toward larger home ranges over time. This increase in home range size over time may be related to a gradual recovery from tag implantation. However, the size of the home ranges of individual fish was significantly different. While some individual fish may move between platforms in the complex, the extent of their movements was consistent with a pattern of short excursions away from, and back to, the area of the complex that was contained in their home range. These excursions were likely centered on feeding activity as blue runner were frequently observed feeding at the surface near platforms.

Some of the blue runner were not detected by the hydrophones for prolonged periods of time during the study. Each of these individuals did eventually return to the platform complex and maintain a presence in the area. As mentioned earlier, the absence of detections may have been due to excursions below the pycnocline or excursions beyond the detection envelope of the hydrophone array. The return of these individuals to the platform complex raises the question of how they were able to navigate back to the complex. The return may be a result of the individuals using the platforms for spatial orientation. Tolimieri *et al* (2000) found that sound can be a navigational cue for pelagic fish larvae. Petroleum platforms are inherently noisy environments and the sounds might be utilized for homing by the blue runner. Clearly more research would be required to test this hypothesis.

This study indicates that blue runner do not exhibit large degrees of long-range movements, but instead center their activities in the immediate vicinity of the structures of the petroleum platform complex. Although long temporal excursions were seen, they were followed by returns to the complex. It is not known where these individuals went, only that they moved out of the range of the detection envelope (Fig. 2.14).

2.4.3 Temporal Activity

The individuals remaining at the platform overnight did not have a significantly different sized home range from that seen during the day. Keenan *et al* (2003) showed that the diet of *C. crysos* was different during the day versus the night, with blue runner consuming a larger proportion of larval fish and other larger and more conspicuous invertebrates at night and zooplankton during the day. The ST151 complex is illuminated with large floodlights that project light down into the water column. Keenan *et al* (2007) demonstrated that the underwater light field around ST151 extended down to 25 m and that sufficient light was likely present to permit feeding. The brightest illumination was located close to the platforms where the lights were concentrated. One hypothesis is that the blue runner forage in deeper water at night to avoid being consumed by larger predators hunting near the surface. Their shift towards larger, more conspicuous prey at night is consistent with feeding in reduced light intensities. Given this, it is reasonable to expect that blue runner would occupy a smaller home range during the night close to the brightest illumination sources. Because the data do not support this hypothesis, it appears likely that blue runner are active and mobile during the night, perhaps moving into regions of bright light to forage periodically and then shifting their location to water that is poorly illuminated to avoid being consumed by visual predators.

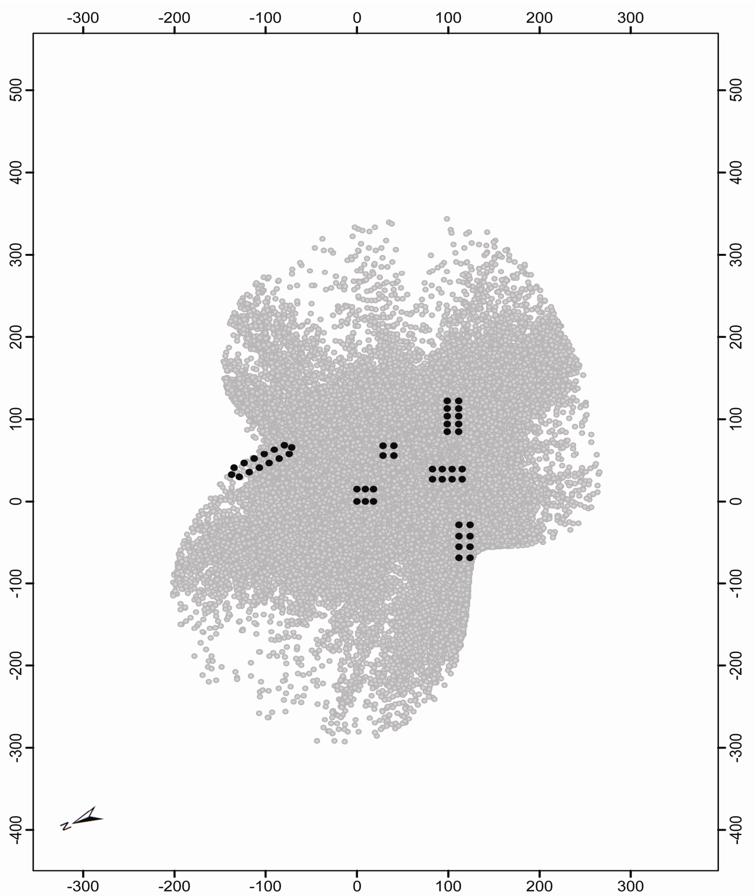

Figure 2.14. The location solutions of all 23 blue runner during the study in August 2005. This figure gives an approximation of the area of the acoustic detection envelope around the ST151 complex. The total area encompassed by all the location solutions shown in 5.62 hectares.

2.4.4 Broad Scale Movement

Nineteen *Caranx* crysos were tagged in 2006. Nine of these were tracked for fewer than 5 consecutive days and one was tracked for fewer than 10 consecutive days. The remaining 9 blue runner were tracked for periods ranging from two weeks to two months in 2006. All of the fish released at the ST151 main complex were found only at the main complex. No long range migration away from the complex was detected. In addition, three of the four fish caught and released at a satellite platform migrated to the main complex and remained there. Only one of the nine fish tagged in 2006 were not detected at the main complex. The migration to the main complex, and the fact that the fish remained at the main complex, further demonstrates the strong site fidelity blue runner exhibited. These findings do not, however, illuminate the reason(s) why blue runner exhibit such strong site fidelity.

2.5 Conclusions

This research is the first example of the use of acoustic telemetry to determine the home range of pelagic fishes. Documenting the spatial distributions of coastal pelagics such as blue runner with high temporal resolution is problematic. While the movements of individual *Caranx crysos* appear to be localized around the petroleum platform complex, the movements of fish are highly dynamic on the scale measured – hundreds of meters. Schools of blue runner are typically found on the upcurrent side of the platforms and the rotatory direction of tidal currents results in fish spending time on all sides of the platform structures. Moreover, schools disperse in response to disturbances from predators, boats, and other factors. Based on visual observations of schools, they are highly dynamic, reforming after disturbances while frequently coalescing and dividing throughout the day.

Both the area encompassing the home range of individual blue runner and the number of localizations were larger during the day than night. While some of the blue runner would not be detected for periods during the night, the fish would return to the complex the following morning. Blue runner may be moving outside the hydrophone detection envelope during the night. It is likely that the reduction in detections at night was a consequence of fish being deeper in the water column where fewer transmission pings were detected on sufficient hydrophones for a position solution to be estimated. For those blue runner that did not appear to leave the platform complex during the night, the artificial light field provided by the platforms may have provided the ability to feed while remaining at a depth sufficient for predator avoidance.

Three possible explanations for the high site fidelity, limited home range and reverse diel vertical migrations of blue runner include increased access to food, increased refuge from predators and increased reproductive success. Further research is needed to more accurately determine the causes of these behaviors. These data show that the fish do occasionally leave the main complex of platforms, but do not indicate where they go or how they navigate back. Furthermore, the study could be expanded to determine if the patterns demonstrated by blue runner are also exhibited by other pelagics.

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CHAPTER 3.

SCHOOLING BEHAVIOR OF BLUE RUNNER (*CARANX CRYSOS*) NEAR PETROLEUM PLATFORMS IN THE GULF OF MEXICO

3.1 Introduction

3.1.1 Schooling

The physical aggregation of organisms occurs across many different taxa of all sizes, from bacteria to whales. Fish may be considered to be aggregating when they react to one another by staying near to each other (Keenleyside, 1955). Breder (1967) defined a school as a group of fish exhibiting a characteristic spatial orientation. This definition is not necessarily consistent with schooling behavior as not all fish in an aggregation are moving in the same direction at any given moment. Shaw (1970) defined a school in a broader manner by stating “to be considered a school, a group must be composed of fish that are *mutually attracted to each other*.” Morrow (1948) defined a fish school as “… a closely-knit, cohesive group, in which there appears to be a definite centripetal influence existing between fish.”

Approximately 50% of all fish species school as juveniles but only about 25% of all fish species continue to school throughout their life cycle (Shaw, 1978). Fish may orient themselves in random directions within a school (non-polarized) or position themselves in a direct line with each other (polarized). Schools are highly dynamic groups that can change size and membership rapidly. Individuals may leave the school to forage or avoid predators before rejoining the same school or moving on to join a nearby school.

The physical mechanism behind schooling involves the fish’s visual and lateral line sensory systems. Partridge and Pitcher (1980) demonstrated that saithe (*Pollachius* *virens*) could use either system to determine their relative position and the direction of the school's movement. The authors used four groups of fish for their study: (1) temporarily blinded individuals; (2) individuals with their lateral lines cut; (3) individuals who were both temporarily blinded and had their lateral lines cut; and (4) an intact control group. They found individuals in groups one and two demonstrated the ability to school that was not significantly different than the control group. Only individuals in group three were unable to school. They concluded the roles of both the visual system and the lateral line system overlapped.

A diel pattern of schooling behavior is generally observable in fish. The most common diel pattern involves fish aggregating into schools during the day but dispersing during the night (Shaw, 1961; Muino *et al*, 2003). However, other patterns have been observed. For instance, jack mackerel (*Trachurus murphyi*) exhibits a reverse pattern with schooling seen during the night. This allows their distribution to overlap with other mesopelagic communities migrating to the surface which provides opportunities for active foraging (Brehmer *et al*, 2007). Bertrand *et al* (2006) suggest the determining factor for schooling behavior or timing may correspond with prey availability during the diel cycle.

Advantages of schooling include larger capacity for food foraging, reduced risk of predation, increased ability to cooperatively hunt, and improved hydrodynamics. Pitcher *et al* (1982) found that schools of minnows (*Phoxinus phoxinus*) spent less time foraging before finding food as the size of the school increased. This decrease in foraging time may come as a result of an increase in the number of individuals actively searching for food; the more eyes available for searching the quicker food can be found.

A second advantage of schooling includes a perceived protection from predators. Hoare *et al* (2004) investigated group size choice in banded killifish (*Fundulus* *diaphanous*). The authors determined that when no risk of predation was present the majority of killifish were found outside of the school, but when the risk of predation increased they responded by forming larger schools. Some individuals and pairs of killifish were noted separately from the schools, even when predators were present. The aggregation of a large number of individuals could decrease the likelihood of a single individual to be available as prey. Major (1978) found that as the population size of the school increased, the number of individuals caught by schooling predators also increased. However, the overall percentage of individuals removed from the prey school actually decreased. Thus, while large schools may make more individuals available as prey, larger schools may provide some relative protection from predators. In addition, experiments have shown that predatory fishes consume more when the prey are solitary as opposed to when schooling (Lim, 1981; Major, 1978) suggesting that predators become more rapidly satiated when feeding on fish in a school.

A third advantage of schooling is the ability to hunt cooperatively. Major (1978) found that schooling predators were more successful at catching schooled prey than predators hunting alone, though solitary hunters were more successful at catching isolated prey than schooling predators. The increased number of individuals present in a school make cooperative foraging more efficient than solitary hunting. Schmitt (1982) demonstrated that cooperatively foraging yellowtail (*Seriola lalandei*) were able to selectively split schools of jack mackerel or Cortez grunts (*Haemulon flaviguttatum*) into smaller groups that could be easily captured.

Another advantage of schooling that is often overlooked is the improved hydromechanics of a group of fish. Wiehs (1973) showed that by positioning themselves in a diamond pattern, the fish in the trailing positions of the school could increase their relative speed by as much as 30%. This leads to a sizeable decrease in the amount of energy required to swim when compared to fish swimming in isolation. The increase in swimming speed also benefits smaller fish in the school that would normally have to expend more energy to maintain the velocities of the larger fish in the school.

Visual observation of blue runner schools from petroleum platforms indicates that the fish spend a large portion of their time feeding at the surface, and that schools regularly break up and reform. While blue runner are generally regarded as a schooling species, the dynamics of their schooling have not been experimentally examined, either in the laboratory or *in situ*. Moreover, since it is only possible to view the blue runner schools during the day, no information is available to determine whether they remain in schooling aggregations at night. Alternatively they may exhibit the stereotypical behavior of schooling fish and spend their nighttime hours in a solitary manner.

3.1.2 Objectives

The goal of this research was to investigate the behavior patterns and schooling of blue runner around petroleum platforms in the Gulf of Mexico. The objectives of this study were to determine:

1. The spatial dimensions of blue runner schools;
2. Whether blue runner exhibit schooling behavior during both day and night;
3. If individual blue runner move between schools, and, if so, how frequently;
4. The location of schools within the water column over a 24 hr period; and
5. The proximity of schools in relation to the structure of the platforms.

3.2 Methods and Study Site

3.2.1 Study Site

The study was conducted from Chevron's South Timbalier 151 (ST151) complex (28°37.000' N, 90°15.367' W), a series of six pla tforms connected by catwalks. Details of the study site are provided in Chapter 2 (Section 2.2.1). The water depth around the platforms ranges between 30–42 m.

3.2.2 Hydrophone Placement

A series of eight underwater hydrophones (LHP-1, Lotek Wireless) were deployed beneath the platform complex. Each hydrophone was linked to a central receiver (Lotek MAP_600) via ruggedized cable. See Chapter 2 (Section 2.2.2) and Appendix A for details of the hydrophone placement, characteristics, and testing.

The MAP_600 tracking system was operational for 23 days (August 5 - 27, 2005) until the study was terminated prematurely due to the impending arrival of Hurricane Katrina. In addition to the hydrophones on the main complex, three unmanned platforms were each outfitted with a single hydrophone (Lotek MAP_RT). See Chapter 2 (Section 2.2.3) for more information on the installation and setup of these hydrophones. All three MAP_RT receivers began collecting data on August 11, 2005. The MAP_RT receivers were shut down and data collection ended at the unmanned platforms on August 26, 2005.

3.2.3 Acoustic Tags

Small, cylindrical 76 kHz acoustic tags (CTP_M11_12, Lotek Wireless) that were 11 mm in diameter and 46 mm long with a mass of 8.2 g in air were used for this project. For more information on the tags and the field testing see Chapter 2 (Section 2.2.4).

3.2.4 Surgical Implantation of Tags

Fish were collected using barbless lures in order to minimize the physical damage to the fish. All fishing and surgical procedures were completed from the Old Quarters platform. See Chapter 2 (Section 2.2.6), Appendix B and Appendix C for more information on the collection of fish and implantation of tags. Between August 5-15, 2005, I released 33 blue runner with 4-second tags and 13 with 2-second tags.

3.2.5 Data Analysis

All telemetry data were imported into BioMAP software (Lotek Wireless) for processing. See Chapter 2 (Section 2.2.7) and Appendix D for more information on the BioMAP software and the filtering of data. Only fish that were tracked for a minimum of 24 hours after they were released were included in this analysis. This precaution both eliminated fish that may not have fully recovered from the surgical tag implantation and allowed time for the fish to return to normal behavior patterns.

Filtered three dimensional localization data were entered into MATLAB (The Mathworks Inc., Natick, MA) and run through a smoothing program which interpolated the localizations on a five second time interval. A MATLAB program was written to concurrently plot the locations of each fish. The plot was incremented at 5 second time steps to permit a visual determination of when fish where schooling. The Euclidean distance of an individual fish relative to the other tagged fish was then calculated using an additional MATLAB program.

One of the challenges in determining whether tagged fish were schooling was to define the distances that define the limits of a school. Given that small number of tagged fish in relation to the total number of blue runner present at the study site, the probability that two fish were in the same school was relatively low. Moreover, if two fish were in the same school, how far apart could they be and still be regarded as within a single school. A MATLAB program was written to visually track all tagged fish at 10 s intervals over several days. By watching the movements and proximities of tagged fish, I was able to measure the distances between fish that appeared to be schooling. This approach was used to estimate the maximum distance that fish were apart yet still appeared to be within a single school.

Visual inspection of the data using this MATLAB program and comparison of the position locations with the calculated Euclidean distances showed that blue runner within 36 m of each other for at least two consecutive time periods (10 sec.) could be considered to be exhibiting schooling behavior. If the fish were not within 36 m for at least two consecutive time intervals then it was possible that the fish may have been swimming past each other and not actually schooling. Therefore, such instances were not considered in the determination of the spatial dimension of the schools. It is possible that fish which were greater than 36 m from the nearest acoustically-tagged fish may have been schooling in association with non-acoustically-tagged fishes; however, in the absence of positional data for non-tagged fish, no determination of whether they were schooling could be made. To compare the mean distance of fish within schools during the day versus night an independent samples t-test was performed in Statistics for Research & Analysis Software Package (SPSS) (SPSS Inc, Chicago, IL).

To determine if the blue runner were exhibiting schooling behavior during both day and night ,the data was broken down into the two time periods using the times for local sunrise and sunset (US Naval Observatory website) at the ST151 complex. Day was defined as the period between 30 minutes after sunrise and 30 minutes before sunset. Night was defined as the period between 30 minutes after sunset and 30 minutes before sunrise. Because of the discrepancy in the number of localizations between the day and night, the percentage of localizations when an individual fish was found to be schooling in each time period over the entire study period was compared using a two-tailed paired t-test in SPSS. A multivariate generalized linear model was run to test for differences in the population of tagged fish in the day/night schooling behavior over the study period, using the categorical variables fish ID and Julian date. To determine if fish move between schools, the times of day that fish were considered to be in a school were plotted and visually compared to determine when different fish were schooling and if the composition of a school changed over time (Zar, 1995).

The two-dimensional center of each of the six platforms in the ST151 complex was determined using the Mean Center tool in ArcMap 9.2 (ESRI). The Euclidean distance between each schooling instance and the center of each platform was calculated. These distances were then separated into day and night variables. The day and night data from each platform were tested to determine if the location of a school differed significantly during the two time periods using two-tailed paired t-tests (α=0.05) in SPSS. In addition the distance data were compared using a single factor ANOVA to determine if the proximity to platforms differed over the study period (Zar, 1995).

3.3 Results

3.3.1 Tagged Fish

Of the 46 *Caranx crysos* that were released with acoustic tags, 32 were tracked for at least 24 hours or longer after release (Fig. 3.1, Table 3.1). This refers to obtaining at least one valid position solution within the 24-h period following release although many more valid positions were obtained in that 24-h period. The schooling analyses were restricted to these 32 individuals. These fish ranged in size from 267 - 391 mm FL and 392 – 747 g (Table 3.1).

All of the 32 blue runner were tracked daily over a continuous period, except fish 32700, which disappeared on August 18 and returned on August 25, fish 33000, which was not located on August 16, 19, and 21-22, and fish 34300, which was not located on August 15-17, and August 19-22. Nine of the fish (30200, 30500, 30600, 32500, 32700, 33000, 33700, 34200 and 34300) were not tracked during some nights, but were detected after dawn on the following day. Fewer localizations occurred during the nighttime hours versus the daytime hours (Fig. 3.2).

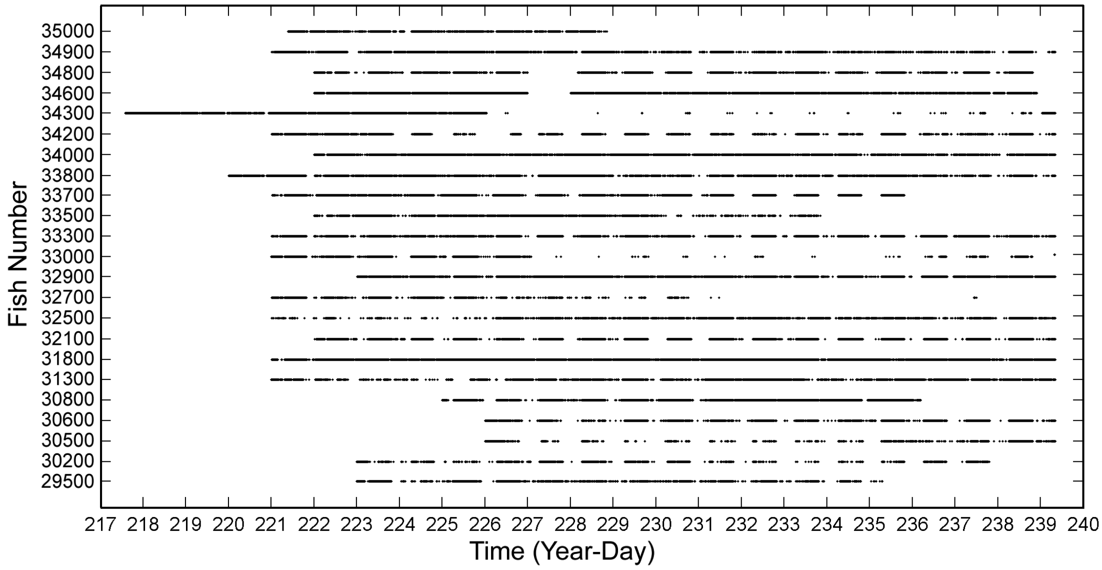

Figure 3.1. Periods when each of the individual blue runner from this were localized over the duration of this study.

3.3.2 Estimation of the Spatial Dimensions of Blue Runner Schools

The mean distance of two tagged fish in a school over the duration of the study period was 20.91 m, with a minimum distance of 0.17 m and a maximum of 36 m (the defined limit). The daytime schooling distances ranged from 0.40 m to 36 m with nighttime schooling distances ranging from 0.17 m to 36 m. The t-test found a significant difference in the mean distance of fish in schools during the day vs. the night ($t=-19,308$, $p<0.001$) with larger mean distances at night (21.48 m) than during the day (20.79 m).

The duration of all schooling events over the entire study period showed variability in the schooling behavior of blue runner. The measured schooling events lasted between 10 and 20,535 seconds (5.7 hours), with a mean duration of 165 seconds. When schooling events were broken down to day and night events a greater difference could be seen. Daytime schooling events had a mean of 312 seconds with a maximum of 18,280 seconds (5.1 hours), and nighttime schooling events had a mean of 54 seconds with a maximum of 1,965 seconds (0.54 hours).

Table 3.1. Identity codes, fork length, mass and the maximum consecutive days at liberty of 32 tagged blue runner that were tracked for at least twenty-four hours following release around ST151 in August 2005.

Code	***Fork Length (mm)***	***Mass (g)***	***Days Tracked***	***Code***	***Fork Length (mm)***	***Mass (g)***	***Days Tracked***
29500	282	407	13	32700	267	397	18
30100	391	401	2	32900	300	442	18
30200	294	442	16	33000	293	400	19
30500	299	462	15	33200	281	406	4
30600	286	405	15	33300	291	407	20
30800	304	403	13	33500	278	486	13
31200	288	413	2	33600	318	562	3
31300	338	624	20	33700	275	392	16
31400	298	425	5	33800	290	390	21
31500	297	458	5	34000	375	747	19
31600	282	421	1	34200	283	408	20
31800	316	482	20	34300	285	375	23
32100	288	493	18	34600	303	527	18
32300	298	413	4	34800	283	392	18
32400	278	392	3	34900	293	401	20
32500	298	455	20	35000	301	469	8

In most cases, a tagged fish was seen in a school with only one other tagged fish, however, it was not uncommon to observe more than two tagged fish in the same school. Multiple schools are often seen around the platforms. The largest number of schools containing tagged fish observed at a given time in this study was four.

3.3.3 Diel Differences in Schooling Behavior

Using a two-tailed paired t-test to compare the percentage of time an individual fish was found to be schooling during the day versus night demonstrated that all but eight of the tagged fish exhibited significantly different schooling behavior over the diel cycle (Table 3.2). All eight of these fish were tracked for four or fewer days. Using the multivariate GLM an overall significant difference was found between day and night schooling patterns (F=51.69 p<0.001) and between schooling patterns of individual fishes (F=3.29, p<0.001), but no difference was found when comparing the fish over the complete time period of the study (Julian date: F=2.49, p=0.084). Each fish was found to be schooling more often during the day than at night.

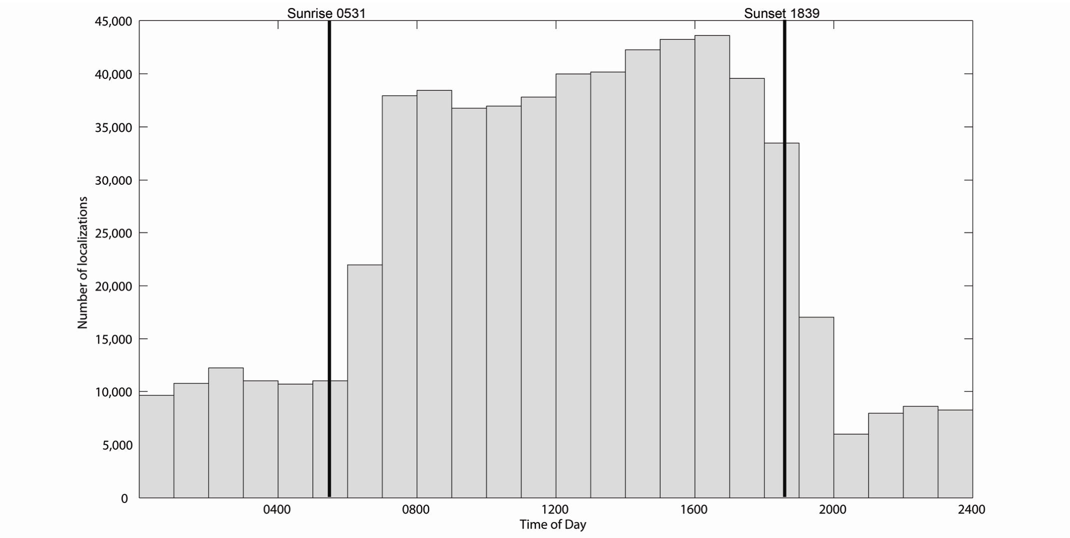

Figure 3.2. The cumulative number of localizations during the entire study period (August 5 – 27, 2005) broken down by one hour periods. The lines bisecting the histogram indicate sunrise and sunset times on August 16, 2007 (the middle of the study period).

The results of the day versus night schooling analysis confirmed that schooling is largely a daytime phenomenon in blue runner. Therefore, it was logical to re-evaluate the overall schooling frequency by restricting the analysis to only daytime detections. The results of that analysis indicate a mean daytime schooling percentage of 57.39 (range of 1.43 - 98.26%). When the fish that were only tracked for four of fewer days are removed from the analysis due to low n, the mean daytime schooling percentage increases to 62.87 (range of 30.69 -87.83%).

3.3.4 Movement between Schools

The times that each tagged fish was within 36 m of another tagged fish were plotted to visually discern which fish were schooling together. While the plots contain large voids they do show instances when multiple tagged fish could be found in the same school and how the composition of each school changed over time. For instance, Fish 29500 (Fig. 3.3) can be seen schooling with multiple fish on year day 223 upon release from the holding pen. However, as the study period progressed the number of fish and the identities of the fish exhibiting schooling behavior with Fish 29500 changed. Another example can be seen with Fish 34600 in Figure 3.4. While there are a number of fish that Fish 34600 appears to regularly school with, several others can be seen moving in and out of the school. The complete record of all periods of schooling of tagged fish can be seen in Appendix F.

Table 3.2. The results of two-tailed t-tests of the diel patterns of 32 tagged blue runner found in schools 36 m or less during the study period (August 5 – 27, 2005). All but eight of the fish showed a significantly different diel pattern. Fish 31600 was tracked for less than 48 hours so not enough data was available for the t-test.

Fish ID	***t-test score***	***P-value***	***Fish ID***	***t-test score***	***P-value***
29500	2.83	0.016	32700	2.92	0.019
30100	12.11	0.052	32900	4.59	0.000
30200	3.63	0.003	33000	2.34	0.033
30500	4.81	0.000	33200	1.70	0.230
30600	4.18	0.001	33300	4.08	0.001
30800	2.29	0.043	33500	3.02	0.012
31200	1.05	0.485	33600	1.85	0.205
31300	4.69	0.001	33700	5.52	0.000
31400	2.15	0.098	33800	4.55	0.000
31500	2.96	0.042	34000	4.30	0.000
31600	-----	------	34200	6.86	0.000
31800	3.63	0.002	34300	2.97	0.007
32100	4.64	0.000	34600	3.79	0.002
32300	1.06	0.368	34800	5.12	0.000
32400	1.12	0.381	34900	3.16	0.005
32500	2.11	0.050	35000	3.07	0.022

3.3.5 Schooling in Relation to the Platforms

All schooling events on a given day were plotted in relation to the platforms. The schools were primarily located around the Yankee and Old Quarters platforms throughout the study period. Schooling by the tagged fish was seen around these two platforms almost exclusively during the three day period of August 9-11 (Fig. 3.5). On August 12 the schools began to move in the direction of the Production 2 platform and then to the Production 1 platform (Fig. 3.5). Very few schooling events can be seen around the Compressor and G-Deck platforms. However, on August 18 (Fig. 3.6) one school was found to be moving directly between the G-Deck and Yankee platforms. On August 26 and 27 (Fig. 3.7) the schooling pattern seemed to be much more sporadic and spread out among the platforms.

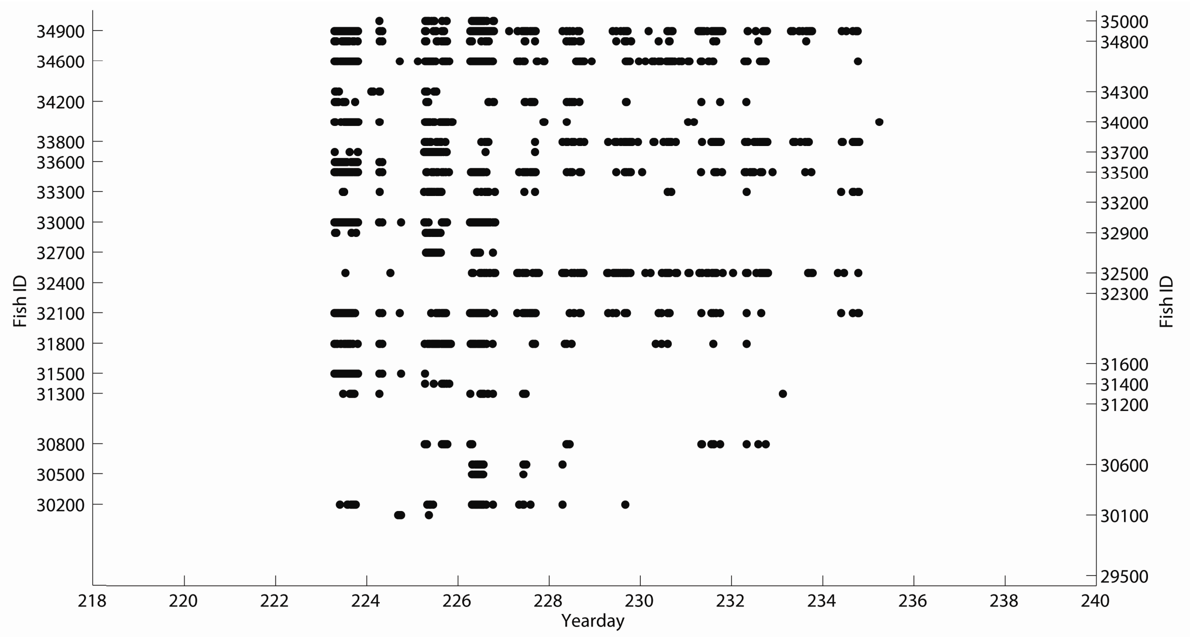

Figure 3.3. The timing of all schooling events for Fish 29500 over the period August 10-27, 2005. Each circle indicates one localization where the two fish were 36 m or less from each other.

A single factor ANOVA showed a significant difference in the location of the schooling events with relation to the two-dimensional center of each of the platforms ($F=3,648,719.75$, $p<0.01$). The data was separated into day and night periods to determine whether schools were localized at varying distances from each individual platform and overall during day and night. The locations of the schools were then compared to each individual platform. Overall there was a significant difference in the location of the schools with relation to the center of all the platforms ($t=-41.47$, $p<0.01$).

In addition, there was a significant difference in the location of the schools during the day and night periods for all individual platforms: Compressor (t=-109.75, p<0.01), G-Deck (t=27.46, p<0.01), Old Quarters (t=-86.02, p<0.01), Production 1 (t=-73.43, p<0.01), Production 2 (t=24.76, p<0.01) and Yankee (t=64.56, p<0.01).

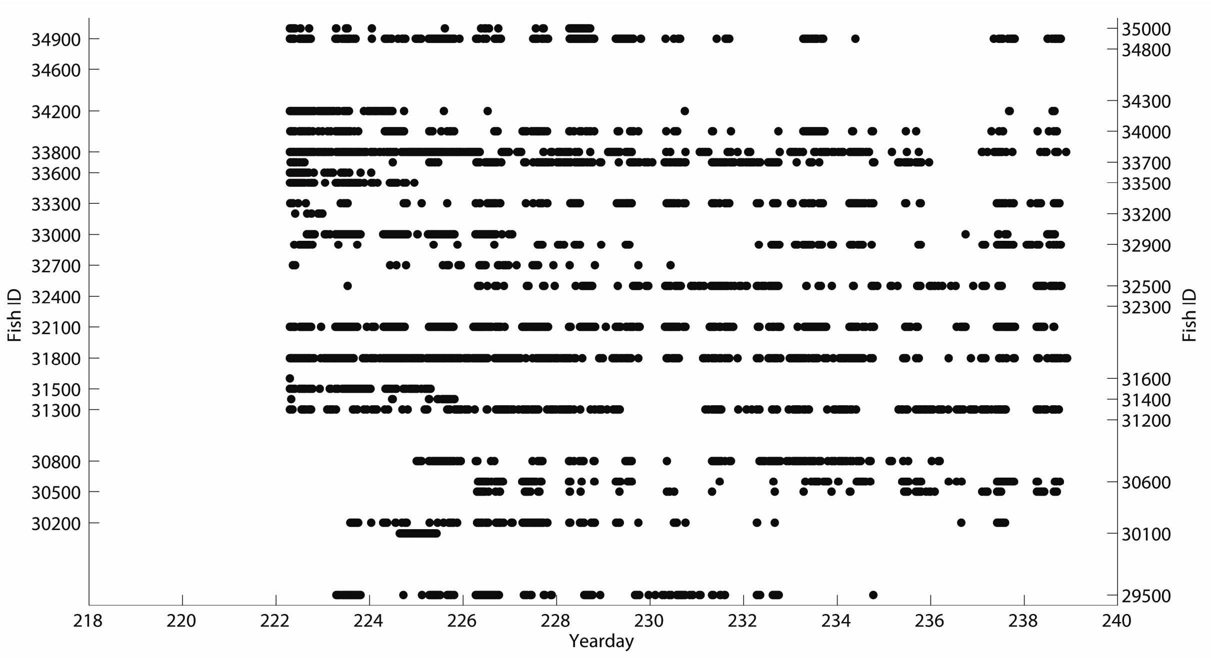

Figure 3.4. The timing of all schooling events for Fish 34600 over the period August 9-26, 2005. Each circle indicates one localization where the two fish were 36 m or less from each other.

3.4 Discussion

3.4.1 Estimation of the Spatial Dimensions of Blue Runner Schools

Caranx crysos has long been considered a schooling fish. Visual observations of their behavior during the day confirmed that large schools of blue runner were present in the vicinity of platform complexes in the Gulf. Watching the behavior of these schools from petroleum platforms 20 m or more above the waters surface it is possible to see hundreds to thousands of fish in schools. These individuals can be seen leaving the school for quick forays before rejoining the school, or splitting off from the school in an attempt to avoid a predator. Based on the frequency of localizations demonstrating schooling behavior with other tagged fish, it seems a reasonable assumption that the blue runner monitored during this study were usually in association with other tagged or untagged fishes. The mean distances between tagged fish was larger at night than during the day, suggesting a less cohesive schooling pattern at night. This is somewhat congruent with the prevailing thought on nocturnal schooling behavior, whereby fish school during the day and disperse at night. The data suggest that blue runner do not completely disperse at night, but do not school as tightly as during the day. While many of the schooling events seen were for short time periods, one school was seen to persist for more than 5 ½ hours and as many as four distinct schools were noted among the tagged fish.

Two of the main proposed advantages of schooling are protection from predation and enhanced foraging (Hoare *et al*, 2004). Eggers (1976) refutes the foraging claim for planktivores by stating that feeding efficiency is decreased due to competition between individual members of the school. This is an interesting supposition given the zooplanktivorous nature of blue runner. Blue runner have been found to feed primarily on zooplankton throughout the day (Keenan *et al*, 2003). Gregson and Booth (2005) studied the response of the schooling reef fish *Trachinops taeniatus* and found that the size of schools increased with copepod density, but a negative relationship existed between number of copepods in the gut and the size of the school. Keenleyside (1955) found that feeding motivation affected schooling size, with higher motivation leading to less schooling behavior. My observations clearly confirm the schooling nature of blue runner during the day. The findings of the telemetry study further support the hypothesis that blue runner are a daytime schooling species. If schooling is a disadvantage for some planktivorous taxa, then the density of zooplankton in the mid-shelf waters where blue runner occur, must be sufficiently high to offset any potential disadvantages associated with securing sufficient food while schooling.

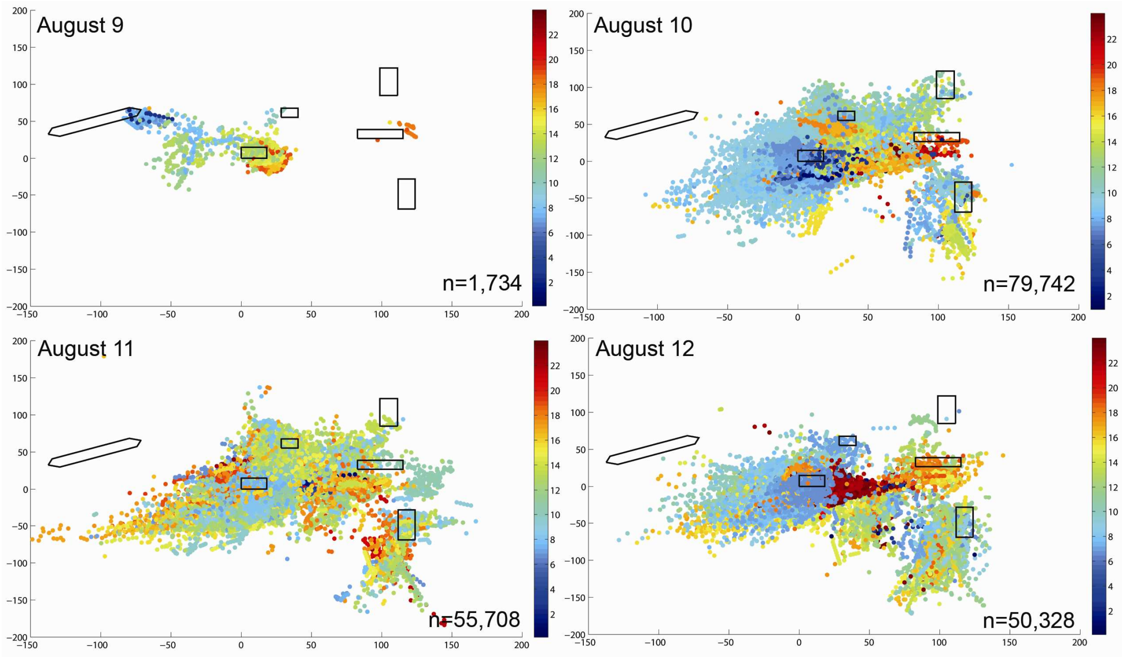

Figure 3.5. The location of all 36 m schooling events of tagged blue runner during the period August 9-12, 2005 are plotted on a continuum with color representing time of day. The location of the platforms is denoted by the black boxes.

The schooling data shows that blue runner did not demonstrate fidelity for a particular school, instead they frequently move between schools. The inherent patchiness of zooplankton may explain periodic solitary foraging times and movement between schools once a higher density patch of food is found. Moreover, it is important to reiterate that tagged blue runner that were apparently solitary during the day, were most likely in close proximity to other non-tagged individuals and hence schooling. Frequent movements between schools may also be a response to regular disturbances of schools by predators and anthropogenic factors, especially common around the platforms.

Determining the size of fish schools is a difficult undertaking. School sizes have been estimated using mathematical models (Aoki, 1981; Hall *et al*, 1986) and measured in laboratory tanks (Godin *et al*, 1987; Hoare *et al*, 2004), but none of these estimates have been verified in the field. Mackinson *et al* (1999) used echosounders and Ferno *et al* (1998) used multibeam sonar to measure the size of herring schools. However, the use of ship-based measuring tools would disrupt blue runner schools which tend to be located close to the surface of the water. Visual observation using underwater camera systems is one possible way to measure the size of schools *in situ*, but this method would present scaling issues based on the distance of the schools from the cameras. The maximum diameter of a blue runner school in this study was determined using a MATLAB program which graphically represented the positions of individual fish. The maximum school size determination of 36 m was used for all the analysis in this study. It is possible that this methodology underestimated the size (diameter) of blue runner schools. Underestimation of school size would have an effect on the statistical results of the analysis.

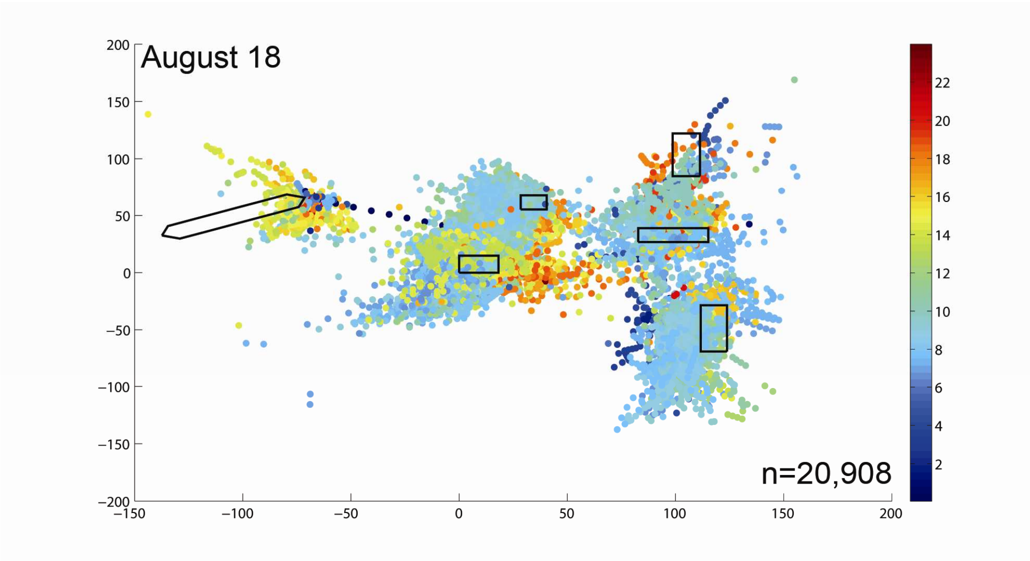

Figure 3.6. The location of all 36 m schooling events of tagged blue runner on August 18, 2005 are plotted on a continuum with color representing time of day. The location of the platforms is denoted by the black boxes.

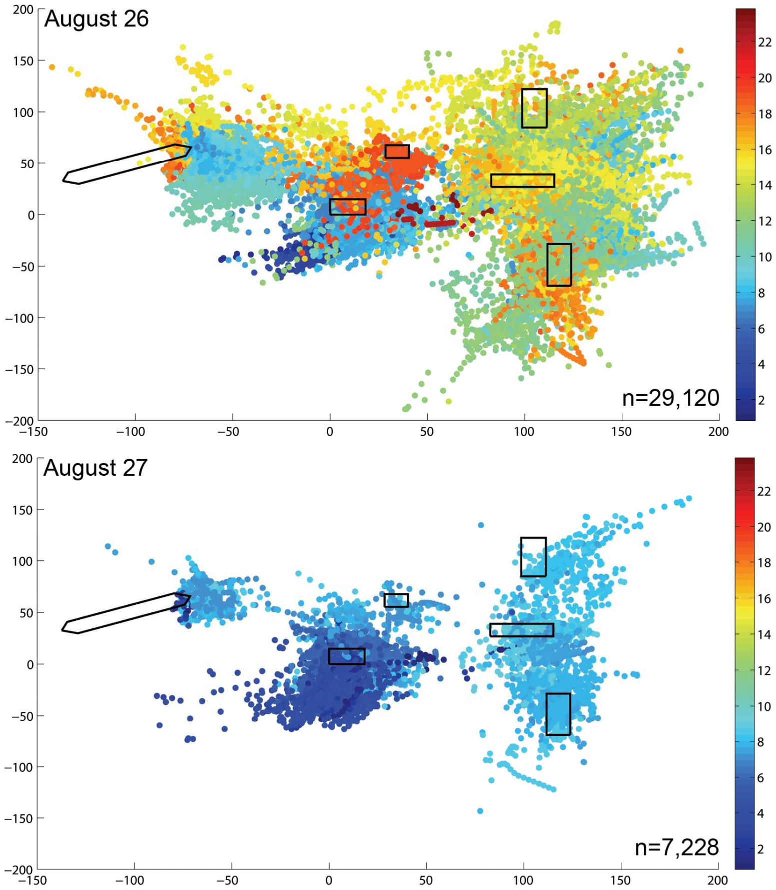

Figure 3.7. The location of all 36 m schooling events of tagged blue runner during the period of August 26-27, 2005 are plotted on a continuum with color representing time of day. The location of the platforms is denoted by the black boxes.

3.4.2 Diel Differences in Schooling Behavior

Typically schooling fish are believed to disperse at night (Cardinale *et al*, 2003; Freon *et al*, 1996; Shaw, 1978). Bertrand *et al* (2004) found jack mackerel exhibited the opposite pattern of schooling, with little, or loose, aggregation during the day and an increase in density at night. The paired t-tests of diel schooling patterns showed that while all of the tagged blue runner exhibited different schooling patterns, the frequency of schooling events were greater during the day relative to the night. The manned platforms at the ST151 complex provide a large light field at night, which may provide sufficient conditions for blue runner to continue to feed (Keenan *et al*, 2007) and likely contribute to the difference in schooling patterns over the diel cycle.

As a number of the schooling events seen at night appear to be contained within the structure of the platforms these events may be aggregations rather than schooling behavior. One instance in which this might be the case is when the fish utilize the structure of the platform to avoid predation.

3.4.3 Movement between Schools

Fish schools are dynamic entities which form, break up, and reform in response to different stimuli. While an individual school may persist for long periods of time, the composition, or individual members, of the school may change (Parrish and Edelstein-Keshet, 1999). Blue runner in this study were observed exhibiting schooling behavior with other tagged fish a relatively small amount of time and could be found schooling with different fish and switching between schools. Figures 3.3 and 3.4 reflect the schooling behavior exhibited by two fish over the course of the study period. These fish were found in schools comprised of different tagged fish on and off throughout the day. All tagged fish were found to move between schools throughout the study period. A highly significant difference was found in relation to the composition of the schools for every tagged fish.

Visual observations of the multiple schools around the platforms match well with what the telemetry data suggests. The large schools of blue runner frequently dissolved in relation to the presence of barracuda and/or sharks and the movement of crew boats around the complex. Once the offending stimulus was no longer present the school would reform. As one school could be seen breaking up, another school could frequently be seen coming to the surface. Individual fish could be seen moving away from the area where the school existed before dissolving, whether or not they returned to the original school, joined the ascending school, or moved on to forage solitarily could not be determined, though.

3.4.4 Schooling in Relation to the Platforms

The results of a single factor ANOVA comparing the location of schooling events relative to the two-dimensional center of the platforms showed a significant difference in the location of the tagged fish with respect to the platforms. The schooling of tagged blue runner occurred primarily around the Yankee and Old Quarters platforms for the duration of the study (Fig. 3.5). This location corresponds with the where the fish were caught (Old Quarters) and where they were released (Yankee). The first few days after release, schooling events were recorded almost exclusively around these two platforms which may be related to a period of recovery from surgery. As the schools moved away from these two platforms they did so in a gradual pattern moving to Production 1 and Production 2 platforms (Fig. 3.6) and rarely around the G-Deck and Compressor platforms. The latter two platforms generate the most noise in the complex and this may account for the lack of schooling events in their general area.

Blue runner demonstrated a significant difference in the location of schooling events relative to the center of the platforms during the day as opposed to the night. The light field around the manned platforms likely plays a role in this difference. During the day sunlight illuminates the entire area equally, but at night the downwelling light supplied by the manned platforms creates a bowl of light that illuminates the upper meters of the water column (Keenan *et al*, 2007). The limited area illuminated by the platforms provides a smaller volume of water available for foraging than would be available during the day and would lead to schooling events closer to the platforms at night.

3.5 Conclusions

Few studies exist documenting the schooling behavior and patterns of pelagic fishes in the field. Most studies have been conducted in the lab and cannot provide a completely realistic setting to study such a dynamic behavior. These studies are problematic due to the dynamic nature of schools and in determining the location of highly mobile fish over long periods of time. During this study 32 fish were effectively tracked over a period of up to three weeks. The distance of each tagged fish from each other and the locations of their schooling events relative to the six petroleum platforms in the ST151 complex were localized. One caveat that should be noted is that the sample size (n=32) is relatively small compared to the large number of blue runner present around the platforms.

The blue runner in this study spent only a small portion of their time schooling with other tagged fish. While the data cannot be used to draw definitive conclusions regarding the amount of time blue runner spend schooling versus time spent away from schools, it does show that they were not confined to one particular school over the course of this study.

The tagged blue runner exhibited different diel patterns of schooling behavior. Fewer schooling events were seen during the nighttime hours compared to daylight, however the mean distances of fish within the nighttime schools were larger than those during the day. While schooling species are typically believed to aggregate during the day and disperse at night, the light field provided by the manned petroleum platforms is likely to allow this deviation from the common diel behavior of schooling species. The schooling data presented here, combined with the findings of Keenan *et al* (2003) on the nocturnal feeding of blue runner, suggests that the fish are active at night and are likely foraging in the downwelled light from the manned platforms. To confirm these behaviors further study is required with an increase in the number of fish tagged.

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CHAPTER 4

DIEL VERTICAL MIGRATION PATTERN OF BLUE RUNNER (*CARANX CRYSOS*)

4.1 Introduction

4.1.1 Vertical Distribution

The pattern of normal diel vertical migration (at depth during the day, at the surface at night) of zooplankton has been widely demonstrated in fresh and saltwater environments (e.g. Mann and Lazier, 1996; Miller, 2004; Lorke et al, 2008). This phenomena is not restricted to zooplankton, as the larvae of many fish species have been shown to undergo a normal diel vertical migration as well (Ahlstrom, 1959; Neilson and Perry, 1990). This migratory pattern is believed to allow the organisms to feed at night while avoiding visual predators. Some fish, on the other hand, undergo a reverse diel vertical migration (at the surface during the day, and at depth at night). Using MOCNESS net sampling off the Oregon coast Auth et al (2007) showed that rockfish larvae exhibited the classical normal diel vertical migration pattern while blue lanternfish larvae exhibited a reverse diel vertical migration pattern.

Nocturnally-active fishes would be more likely to exhibit diel vertical migration patterns that coincide with the distributions of their specific prey items, such as zooplankton or ichthyoplankton. Such a strategy would require adequate light for visually aided prey capture or alternate sensory capabilities to allow for capture. Holzman and Genin (2003) found nocturnal coral reef fish, such as the cardinalfish *Apogon annularis*, were able to catch larger prey items than diurnal species in the same area. Even though the larval fish density was lower at night in their study, the available prey were larger and had higher energy contents, which offset potential energetic losses due to the increased cost of nocturnal foraging.

The majority of studies on vertical distribution of fishes have been undertaken using net sampling at discrete depths. The abundance of each fish species at a given depth is then compared. Due to net selectivity, this work has largely addressed the migrations of larval and juvenile fishes. In more recent years the use of acoustic tags has become more common, but only on larger pelagic fishes through the use of archival tags. Shepard et al (2006) tagged basking sharks using popup archival transmitting tags which recorded pressure and other environmental parameters. They found five of their six sharks underwent a diel vertical migration and one shark underwent a rhythmical migration which coincided with the tidal cycle. Schaefer and Fuller (2007) used archival tags to study the vertical movements of skipjack tuna. They found two distinct behaviors. In the days following release while the ship was still moored in placed the tuna could be found in the upper 50 m of water during both day and night. However, within 48 hours of becoming unassociated with the ship the tuna exhibited repetitive bouncing behavior between 50 and 300 m during the day and remained in the upper 50 m at night.

Although research has been conducted on vertical movements of larvae, juveniles and adults of large, schooling pelagics, there is a dearth of information regarding the adult stages of smaller or intermediate sized pelagic fishes. This lack of data is likely due to the ability of pelagic fish to avoid nets and the inability to use the large archival tags on the smaller fish.

Under normal circumstances, intermediate sized pelagic fishes that feed on zooplankton/micronekton who undergo a nocturnal ascent, must either forage at depth during the daytime when prey densities in surface waters are reduced, or migrate to the surface at night and attempt to forage in the low-light conditions that prevail after dark. Offshore petroleum platforms provide a different sceanario for study. Lights from these platforms enhance nocturnal foraging opportunities at the surface for zooplanktivorous fishes (Keenan et al. 2007), while rendering them more vulnerable to attack by piscivores. This foraging behavior could be classified as one of two types of behavior: passive or active. Passive foraging is characterized by periods of little to no movement followed by short bursts of high speed (ambush). The general lack of activity would serve to allow the fish to hide from predators, though the quick bursts of speed my draw more attention to the fish. Active foraging is characterized by almost continuous slower motion throughout the area. The movement throughout the area might draw attention to the fish, but the continuous motion may allow for more vigilance (Bond 1996). How zooplanktivorous fishes, such as blue runner, balance foraging opportunities with predation risk is an interesting, but unaddressed question.

4.1.2 Objectives

The overall focus of this part of the study was to study the nocturnal distribution and nighttime behavior of blue runner in the presence of petroleum platforms in the Gulf of Mexico. The specific objectives were to determine:

1. If blue runner exhibit a vertical migration pattern;
2. The diel vertical migration pattern of blue runner at manned (brightly-illuminated) and unmanned (illuminated only for navigation) platforms;
3. Whether blue runner exhibit passive or active foraging behavior at night; and
4. The physical location of blue runner at night in relation to the petroleum platforms.

4.2 Methods and Study Site

4.2.1 Study Site

The study was conducted from Chevron's South Timbalier 151 (ST151) complex (28°37.000' N, 90°15.367' W), a series of six pla tforms connected by catwalks. Details of the study site are provided in Chapter 2 (Section 2.2.1). The water depth around the platforms ranges between 30–42 m.

4.2.2 Hydrophone Placement 2005

A series of eight underwater hydrophones (LHP-1, Lotek Wireless) were deployed beneath the platform complex. Each hydrophone was linked to a central reciever (Lotek MAP_600) via ruggedized cable. See Chapter 2 Section 2.2.2 and Appendix A for details of the hydrophone placement, characteristics, and testing. In addition to the hydrophones on the main complex, three unmanned platforms. See Chapter 2 (Section 2.2.3) for more information on the installation and setup of these hydrophones. The MAP_RT receivers were shut down and data collection ended at the unmanned platforms on August 26, 2005, due to the impending arrival of Hurricane Katrina.

4.2.3 Hydrophone Placement 2006

Due to the damage caused by Hurricane Katrina, the use of the cabled MAP_600 system was not possible during 2006. In its place Lotek Wireless WHS_3050 submersible data loggers were used. On August 14 – 15, 2006 nine WHS_3050s were deployed on the legs of platforms around the main complex and "The Circle", while a tenth WHS_3050 was deployed on August 21, 2006. Seven hydrophones were deployed around the ST151 main complex and the remaining three hydrophones were deployed at unmanned platforms: ST128 Romeo, ST151 Kilo and ST152 Poppa. For more information on the deployment, setup and recovery of the hydrophones in 2006 see Chapter 2 (Section 2.2.3).

4.2.4 Acoustic Tags 2005

Small, cylindrical acoustic tags (CTP_M11_12, Lotek Wireless) that were 11 mm in diameter and 46 mm long with a mass of 8.2 g in air were used for this project. For more information on the tags used in 2005 and the field testing see Chapter 2 (Section 2.2.4).

4.2.5 Acoustic Tags 2006

As in 2005 the CTP_M11_12 (Lotek Wireless) acoustic tags were used. Nineteen tags were set to transmit at ten-second intervals (0.1 Hz) with an expected lifespan of 90 days. All tags were equipped with temperature and pressure sensors and these data were transmitted on alternate pings along with the identity number.

4.2.6 Surgical Implantation of Tags

Fish were collected using barbless lures in order to minimize the physical damage to the fish. All fishing and surgeries were done from the Old Quarters platform in 2005. See Chapter 2 (Section 2.2.6), Appendix B and Appendix C for more information on the collection of fish in 2005 and implantation of tags. Between August 5-15, 2005, 46 blue runner were caught, tagged and released, 33 with 4-second tags and 13 with 2-second tags.

In 2006 all fishing and surgeries were conducted from a chartered sport fishing vessel (M/V Different Drummer). Implantation of tags took place on August 21-24. A total of 19 blue runner were caught and tagged during this period. All fish were tagged with 10-second ping rate tags. For more information on the collection and tagging protocol in 2006 see Chapter 2 (Section 2.2.6)

4.2.7 Data Analysis

All telemetry data were imported into BioMAP software (Lotek Wireless) for processing. See Chapter 2 (Section 2.2.7) and Appendix D for more information on the BioMAP software and the filtering of data. Only fish that were tracked for a minimum of twenty-four hours following release were included in the analysis.

The pressure sensor data from both 2005 and 2006 was imported into MATLAB and reduced to the daytime and nighttime data points as above. Daytime was defined as the period between 30 minutes after sunrise to 30 minutes before sunset. The overall day and night depth data were compared using a two-tailed t-test (α=0.05) in MATLAB. An independent samples t-test was used to compare the nighttime depth distribution of blue runner at unmanned versus manned platforms. The timer on the hydrophone at ST151K (unmanned platform) did not function properly and data was only recorded from midnight to 2:24 AM on each day during the 2006 study period. Therefore the comparison of depth distribution at manned and unmanned platforms was restricted to this 2.4 hour period each day. The rate of vertical migration through the water column was calculated and compared with a paired t-test. A General Linear Model was used to test for effects of moon periodicity (defined as percent illumination) and time elapsed since release on the rates of fish ascent and descent. To further test for the effect of lunar periodicity on vertical migrations, Pearson's product moment correlation was used to look for relationships in the amplitude of vertical migration and/or maximum depth of vertical migration with lunar illumination (Zar 1995). Lunar phase illumination was not corrected for local cloud cover as such data were not recorded during the study. Raw data were used for all statistical tests, but the data were binned into five minute intervals for graphical representation.

The distinguishing factor between active and passive behavior (ambushing versus foraging) can, in theory, be determined through the use of swimming speed. Periods of little to no movement followed by quick bursts of high speed may be used to infer an ambush (passive) strategy of feeding, as opposed to longer bursts of high speed which may be indicative of predator avoidance. On the other hand, prolonged periods of slow movement throughout the area can be used to show a foraging (active) strategy of feeding. The distance traveled between successive three-dimensional localizations of tagged fish in 2005 and the time between them was used to calculate the swimming velocities. The velocities were compared to determine if the tagged fish exhibited active or passive behaviors at night. A Kolmogorov-Smirnov test was performed in SPSS to test for differences in the swimming speeds of blue runner during the day and night (Zar 1995).

The two dimensional center of the platforms in the complex was computed using the Mean Center tool of ArcMap 9.2. The Euclidean distance of each fish from the center of the platform was calculated. A single factor ANOVA was used to compare distances of each fish from the center of each platform to determine if the individual fish showed a preference for a particular platform at night (Zar 1995).

4.3 Results

4.3.1 Tagged Fish

Of the 46 *Caranx crysos* released with acoustic tags during 2005, 32 were tracked for at least 24 hours following release (Fig. 4.1, Table 4.1). Diel vertical migration analyses were restricted to these individuals. These fish ranged in size from 267 - 338 mm FL and 397 – 747 g (Table 4.2).

Table 4.1. Identity codes, fork length, mass and the maximum consecutive days at liberty of 46 tagged blue runner that were tracked around ST151 in August 2005.

Code	***Fork Length (mm)***	***Mass (g)***	***Days Tracked***	***Code***	***Fork Length (mm)***	***Mass (g)***	***Days Tracked***
29500	282	407	13	32300	298	413	5
29600	279	387	3	32400	278	392	3
29800	281	390	1	32500	298	455	20
29900	289	432	6	32600	284	418	2
30000	281	398	2	32700	267	397	18
30100	291	401	2	32800	304	448	3
30200	294	442	16	32900	300	442	18
30300	304	403	1	33000	293	400	19
30400	295	442	2	33200	281	406	5
30500	299	462	15	33300	291	407	20
30600	286	405	15	33500	278	486	13
30700	321	480	2	33600	318	562	4
30800	304	403	13	33700	275	392	16
31200	288	413	6	33800	290	390	21
31300	338	624	20	34000	375	747	19
31400	298	425	5	34100	311	560	3
31500	297	458	5	34200	283	408	20
31600	282	421	5	34300	285	375	23
31800	316	482	20	34500	318	527	2
31900	261	381	2	34600	303	527	18
32000	296	493	6	34800	283	392	18
32100	288	493	18	34900	293	401	20
32200	335	614	2	35000	301	469	8

All blue runner were tracked daily over a continuous period, except: fish 32700, which disappeared on August 18 and returned on August 25; fish 33000, which was not located on August 16, 19, and 21-22; and fish 34300, which was not located on August 15-17 and August 19-22. Ten fish (30200, 30500, 30600, 32500, 32700, 33000, 33700, 34200, 34300, and 34200) were not tracked during some nights, but would return the next day. The number of localizations was fewer during the night hours versus the day hours (Fig. 4.2). Overall the number of times an individual fish was located at the platforms during the day versus the night was significantly higher for all but five of the tagged fish based on t-test (α=0.05). Of those five 30200, 30500, 31300 and 34600 had significantly higher numbers during the day than at night based on t-test (α=0.10). Only fish 34000 did not have a significantly greater number of localizations during day and night. Of the nineteen blue runner tagged in 2006 (Table 4.2), only thirteen were detected long enough for their vertical movements to be analyzed.

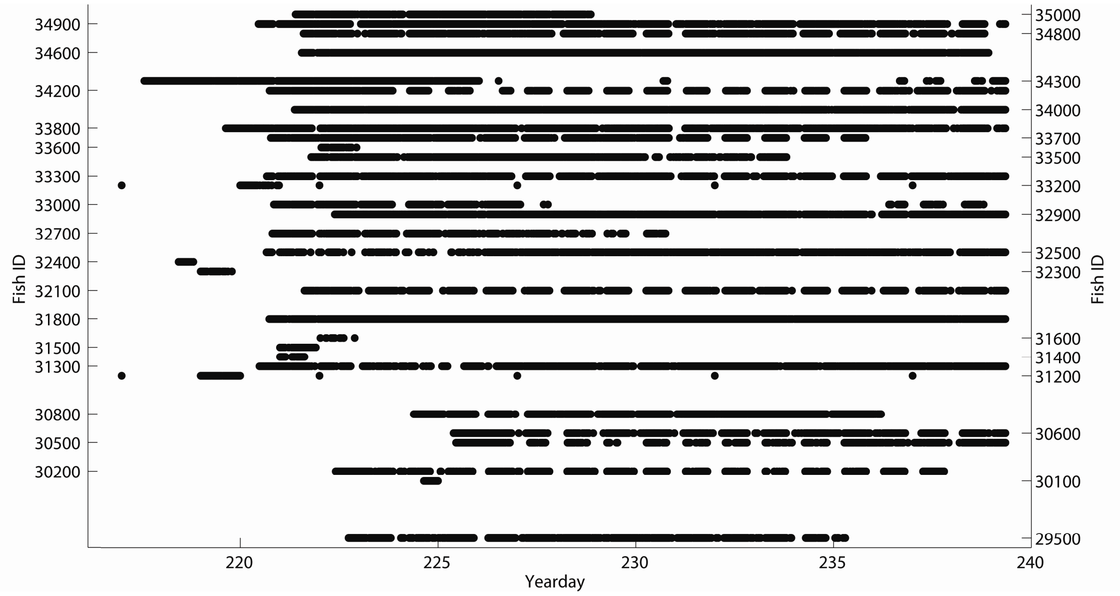

Figure 4.1. Periods during 2005, when each of the 32 individual blue runner from this were localized over the duration of this study.

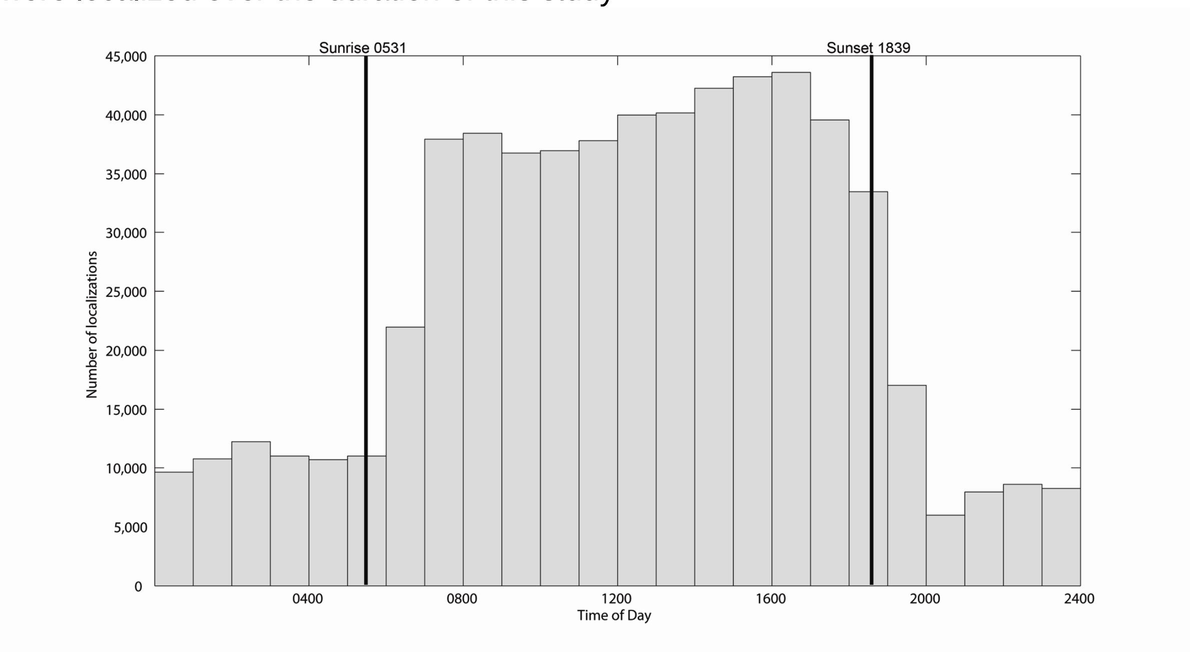

Figure 4.2. The cumulative number of localizations during the entire study period (August 5 – 27, 2005) broken down by one hour periods. The lines bisecting the histogram indicate sunrise and sunset times on August 16, 2007 (the middle of the study period).

4.3.2 Vertical Distribution

Blue runner showed a marked reverse diel vertical migration pattern with fish predominantly in the upper 10-15 m of the water column during the day and in the 20-30 m depth range at night (Figs. 4.3 and 4.4). A descent to deeper water during the dusk to early evening hours was typical of the tagged blue runner, as was a more rapid ascent to the surface waters in the dawn and early morning hours (e.g Fish 33500, Fig. 4.5). Once fish were at depth in the nighttime hours they would frequently show a gradual move into shallower depths over the course of the night before moving back surface waters shortly before dawn. While the tagged fish did not stay at a constant depth for long periods during the day, a pronounced movement to deeper waters was frequently seen in the early afternoon hours as can be seen in Figure 4.5, though this afternoon descent was not evident in all fish, nor was it seen on every day.

Table 4.2. A listing of the blue runner tagged and released for monitoring in 2006. The table shows the date the fish was caught and surgically implanted with an acoustical tag and the fork length (mm) of the fish. Refer to Chapter 2 (Figure 2.6) for locations of capture and release sites.

Date Collected	*Tag ID Number*	*Fork Length*	*Collection Location*	*Release Location*	*Days Detected*
August 21	30900	345	ST151K	ST151K	13
August 21	34700	318	ST151K	ST151K	1
August 21	34800	329	ST151K	ST151K	40
August 21	34900	330	ST151K	ST151K	14
August 21	35000	296	ST151K	ST151K	48
August 21	35100	321	ST151K	ST151K	51
August 21	35300	340	ST151K	ST151 Complex	46
August 21	35500	317	ST151K	ST151 Complex	14
August 21	35600	323	ST151K	ST151 Complex	3
August 22	35700	328	ST151 Complex	ST151 Complex	1
August 22	35900	281	ST151 Complex	ST151 Complex	37
August 22	36100	272	ST151 Complex	ST151 Complex	2
August 22	36400	311	ST134W	ST151 Complex	3
August 22	36500	316	ST134W	ST151 Complex	43
August 24	36600	292	ST151K	ST151 Complex	1
August 24	36700	286	ST151K	ST151 Complex	1
August 24	37000	298	ST151K	ST151 Complex	1
August 24	36800	262	ST151K	ST151 Complex	2
August 24	36900	271	ST151K	ST151 Complex	1

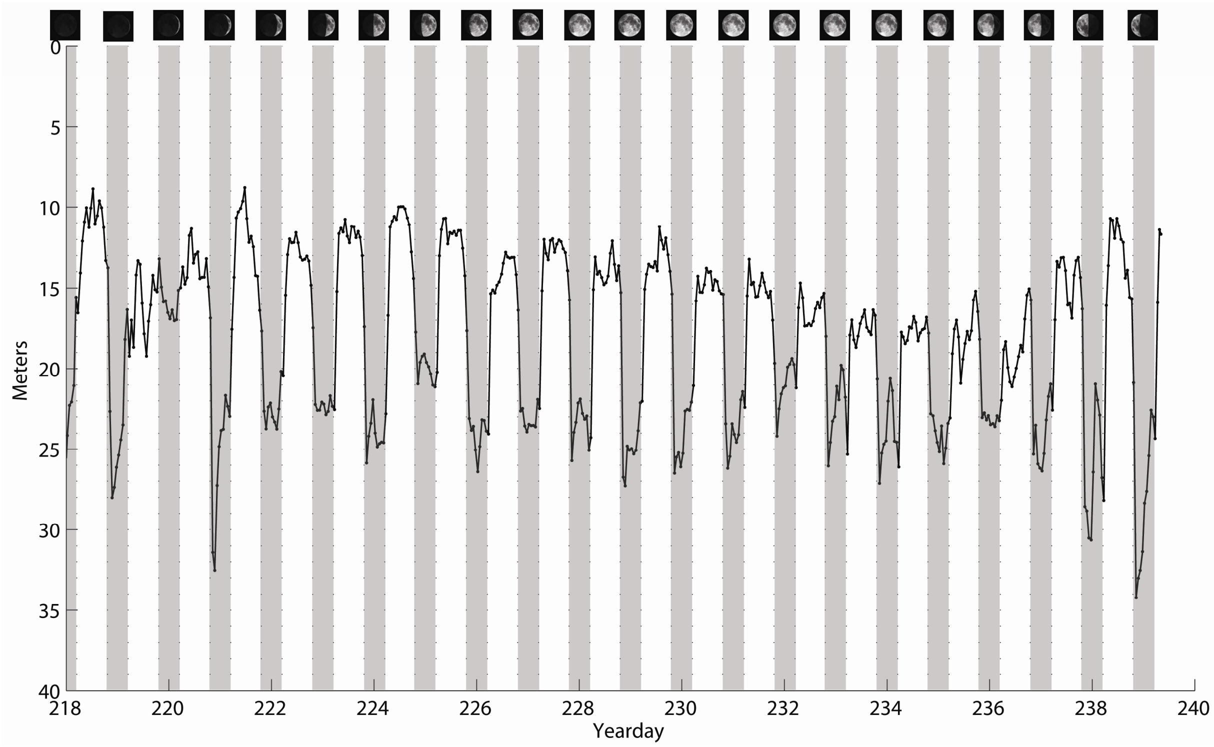

Figure 4.3. The mean vertical position of all 32 fish throughout the 2005 study period. The data are binned into 5 minute intervals. Lunar periodicity is shown at the top of the figure.

In 2005 the vertical distribution of all blue runner during the diel cycle was statistically different when comparing day versus night. The blue runner were almost entirely absent from the upper 10 m of the water column during the night (e.g. Fish 33800, Fig. 4.6). However, the fish did not all show the same pattern of vertical distribution. T-tests showed a high degree of difference ($p<0.01$) for every fish tracked, except Fishes 31600 and 32700 (Table 4.3). The daytime and nighttime vertical distributions for Fish 32700 were almost statistically identical ($p=0.988$). The diel vertical migration pattern seen troughout the study can be illustrated by the distributions of the following three fish. The most common pattern was exhibited by Fish 32500 in that the fish remained below 20 m for most of the night with occasional forays up to the 5-10 m zone (Fig. 4.7). In contrast, Fish 31800 was not bound to small vertical forays at night, but seemed to make larger excursions up and down throughout the water column (Fig. 4.8). And Fish 34000 was never found in the upper 10 m of the water column during the day or night (Fig. 4.9). Additional plots showing the vertical distribution of each of the blue runner in 2005 can be found in Appendix G. Raw data were used for all statistical tests, but the data have been binned into five minute intervals for graphical representation.

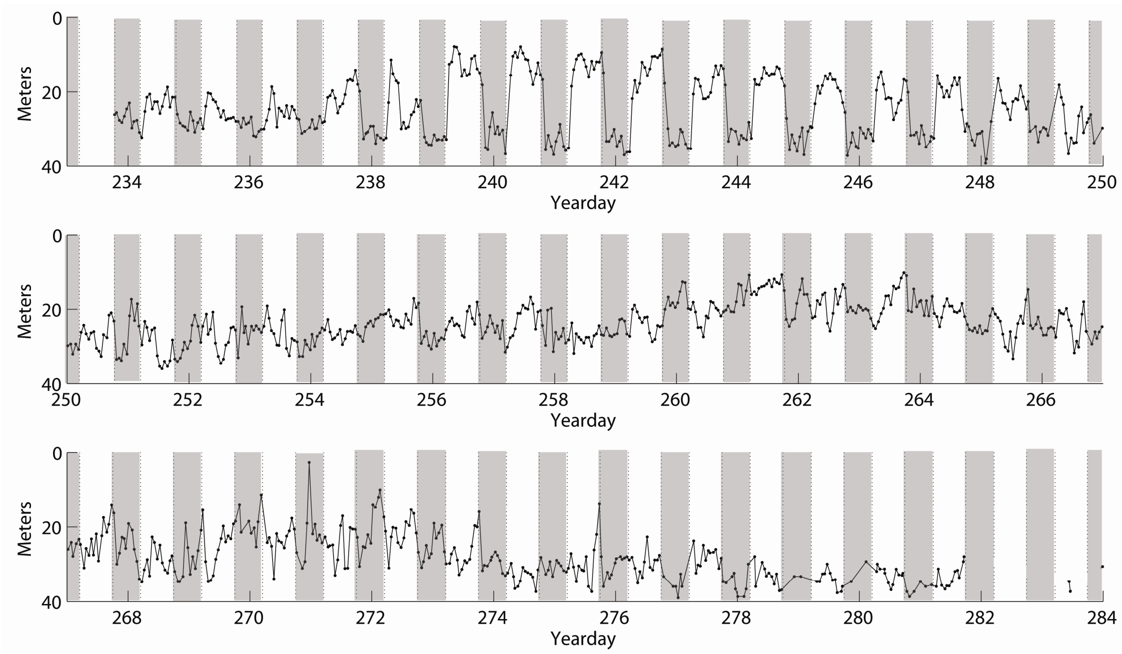

Figure 4.4. The mean vertical position of all 13 fish throughout the 2006 study period. The data are binned into 60 minute intervals.

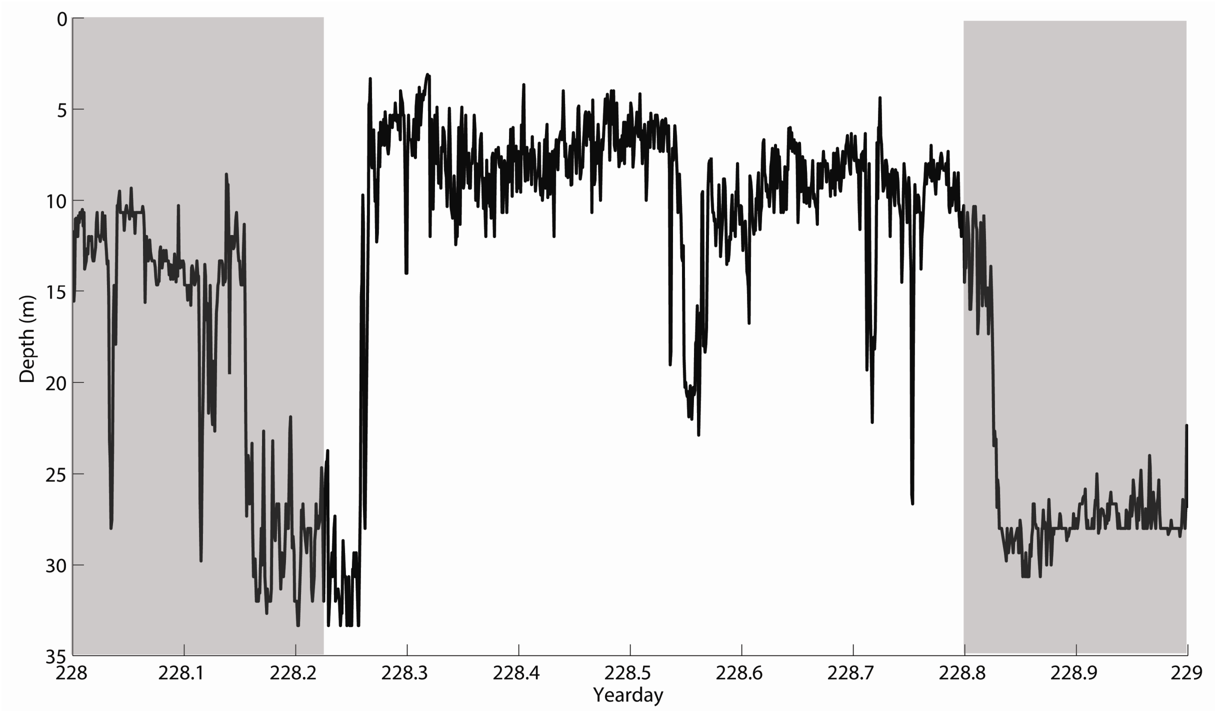

Figure 4.5. The vertical distribution of Fish 33500 on Yearday 228 (August 17, 2005). The data are binned in one minute intervals.

For the first 20 days of the 2006 study the vertical migration pattern was very similar to that seen in 2005, with descents to about 30 m noted at dusk and ascents to the surface at dawn. However, after September 11 (day 253) the amplitude of the vertical migration was greatly reduced to such a degree that diel vertical migration patterns were not evident. Starting with September 29 (day 274) the tagged fish were rarely even found above 20 m (Fig. 4.4).

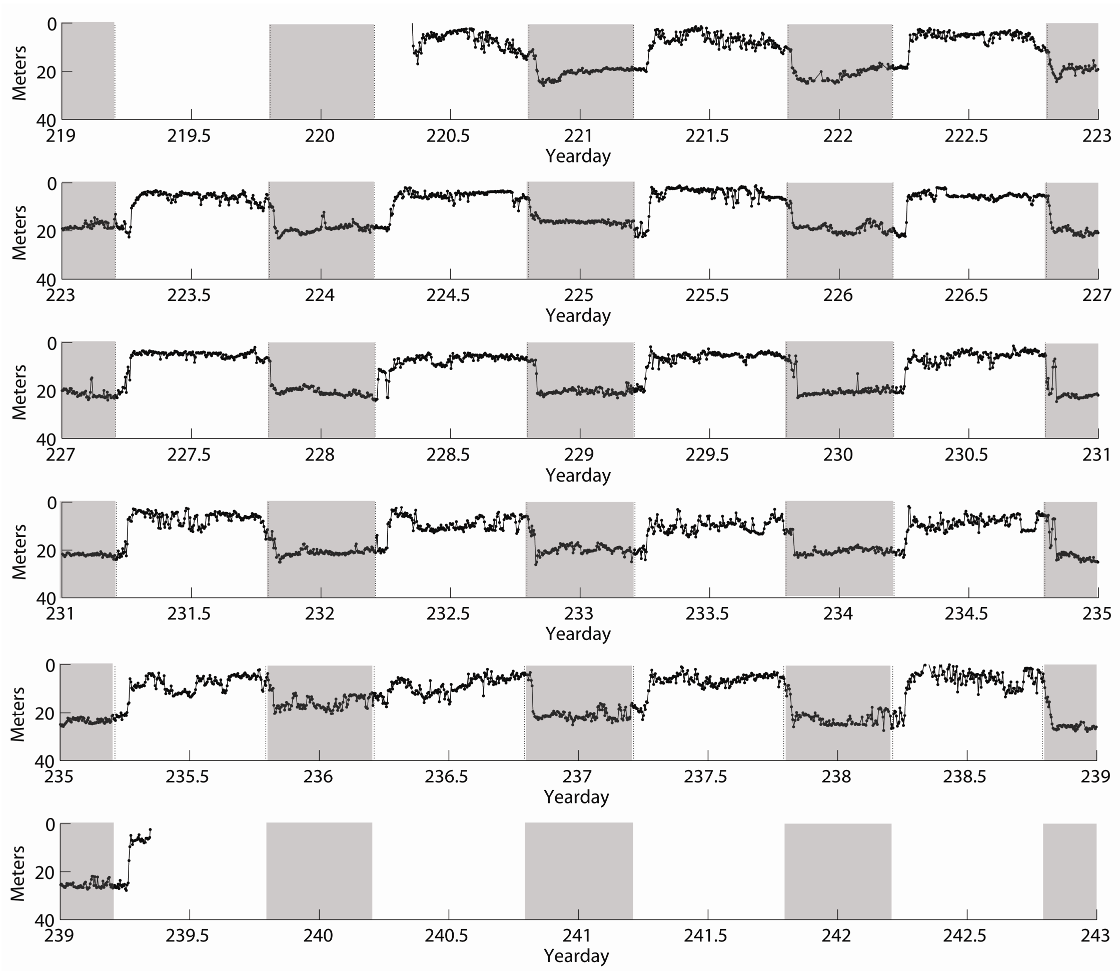

Figure 4.6. The day and night vertical distribution of Fish 33800 in 2005 are represented with the shaded areas indicating nighttime. The data are binned into 5 minute intervals.

In 2006 the vertical distribution of blue runner during the diel cycle was also statistically different when comparing day versus night. T-tests showed a high degree of difference (<0.01) for nine of the thirteen fish tracked (Table 4.4). Fish 30900 had no daytime detections during the entire study period (Fig. 4.10).. As in 2005 the fish were absent from the upper 10 m of the water column during the night. However, they were absent from the upper 10 m of the water column during the day as well. The vertical distribution of the tagged fish in 2006 was more varied than that seen in 2005. Fish 35100 was detected only during the night during the first two weeks after release and almost exclusively below depth of 20 m before being detected throughout the water column both day and night following that time (Fig. 4.11).

Table 4.3. A two-tailed t-test (α=0.05) was run on the depths of each fish comparing their day and night vertical distributions in August 2005. Every fish showed a strong significant difference in their depth distributions, except Fishes 31600 and 32700.

Fish ID	***t-value***	***P-value***	***Fish ID***	***t-value***	***P-value***
29500	-61.23	<0.001	32700	0.02	0.988
30100	-18.85	<0.001	32900	-64.88	<0.001
30200	-6.58	<0.001	33000	-41.95	<0.001
30500	-13.12	<0.001	33200	-5.46	<0.001
30600	-28.01	<0.001	33300	-100.65	<0.001
30800	-39.95	<0.001	33500	-30.40	<0.001
31200	10.91	<0.001	33600	-16.64	<0.001
31300	6.95	<0.001	33700	-73.40	<0.001
31400	-16.44	<0.001	33800	-94.60	<0.001
31500	-15.92	<0.001	34000	7.81	<0.001
31600	-0.83	0.409	34200	-50.16	<0.001
31800	-37.48	<0.001	34300	-50.75	<0.001
32100	-86.78	<0.001	34600	-7.87	<0.001
32300	8.06	<0.001	34800	-64.70	<0.001
32400	-9.64	<0.001	34900	-103.41	<0.001
32500	-73.88	<0.001	35000	-5.72	<0.001

A more common vertical distribution of the tagged fishes in 2006 can be seen in Fish 35500 (Fig. 4.12) with little variation seen in the depth pattern both day and night. More plots showing the vertical distribution of blue runner in 2006 can be found in Appendix G. The nighttime vertical distribution of blue runner at the unmanned platforms was significantly different from those at the manned platforms. Fish at unmanned platforms has a mean depth of 31.61 m, while those at the manned platforms had a mean depth of 24.09 m. The hydrophone at the unmanned platform did not function as planned and only recorded data from midnight to 2:24 AM each day. The distribution analysis was restricted to that 2.4 hour period. Four fish were tracked at ST151K and twelve fish were tracked at the main complex.

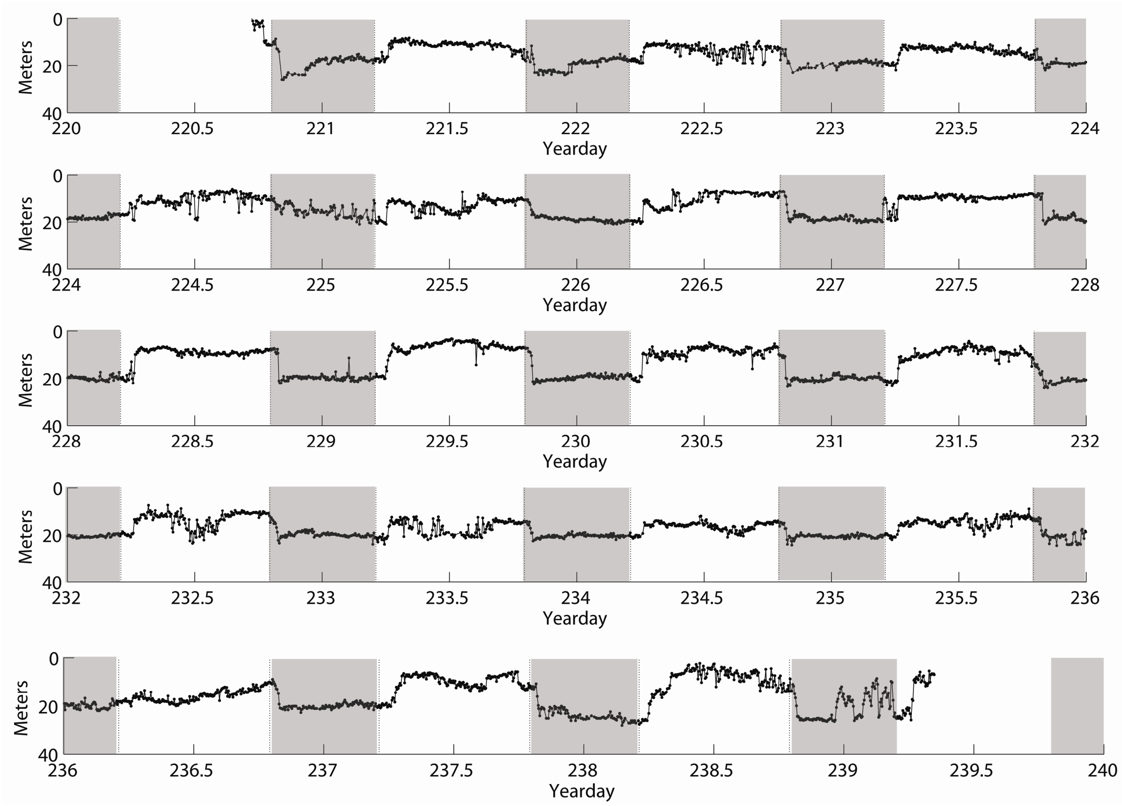

Figure 4.7. The day and night vertical distribution of Fish 32500 in 2005 are represented with the shaded areas indicating nighttime. The data are binned into 5 minute intervals.

The mean rate of descent for all fish in 2005 ranged from 0.07 to 1.86 cm/s with an overall mean of 0.6 cm/s. The mean rate of ascent for all fish ranged from 0.17 to 4.17 cm/s with an overall mean of 1.2 cm/s (Table 4.5). A paired t-test showed a significant difference between the rates of ascent and descent ($t=-2.272$, $p=0.024$). A General Linear Model showed that there was a difference between the ascent rates of individual fish ($F=2.26$, $p<0.001$), with days at liberty ($F=3.22$, $p<0.001$) and the interaction of days at liberty and lunar periodicity (F=2.63, p<0.001), but no effects due to the lunar periodicity alone (F=1.50, p=0.089). A significant difference was also seen in the rates of descent between individual fish (F=1.036, p=0.003), but not from the effects of the lunar periodicity (F=0.80, p=0.702), days of liberty (F=0.64, p=0.868), or the interaction of the two (F=0.86, p=0.77). No significant correlation was seen in the amplitude of vertical migration (r=-0.20, p=0.362) or the maximum depth of migration (r=-0.20, p=0.364) with lunar periodicity.

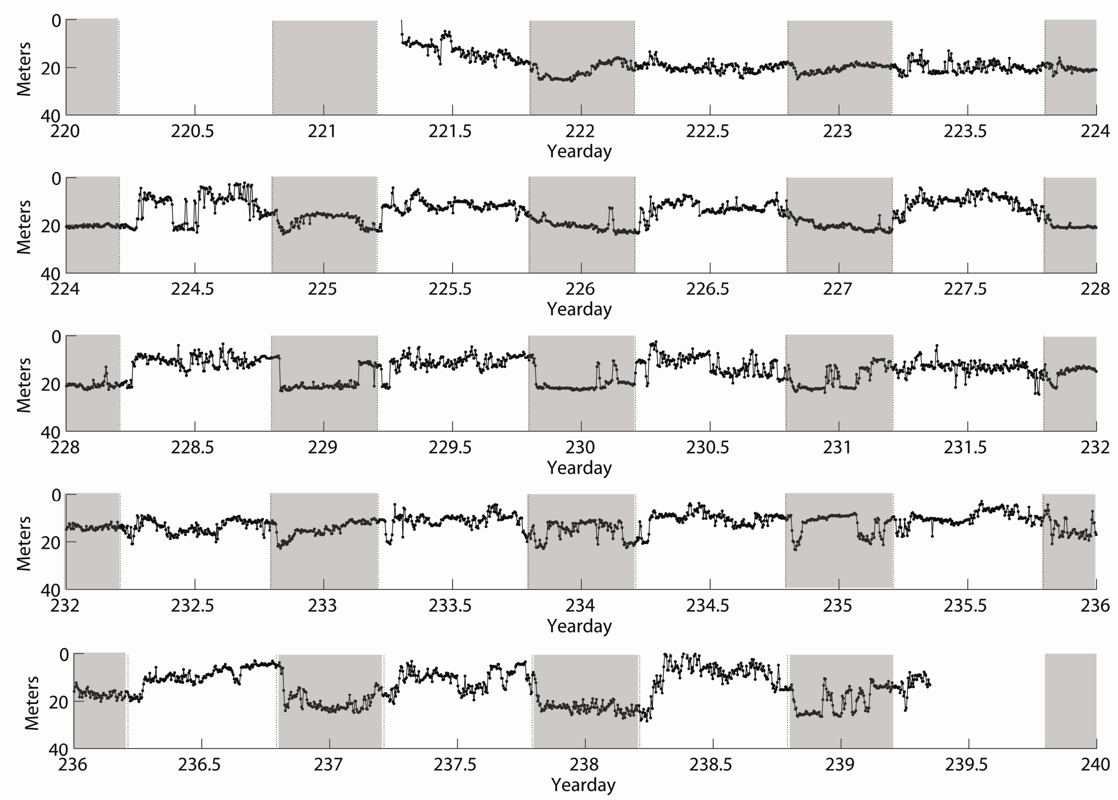

Figure 4.8. The day and night vertical distribution of Fish 31800 in 2005 are represented with the shaded areas indicating nighttime. The data are binned into 5 minute intervals.

4.3.3 Nocturnal Swimming Behavior

A significant difference was seen in the swimming speed of all the tagged fish, with the exception of Fish 31600, with swimming speeds higher during the day than at night (Table 4.6). Fish 31600 did not have enough nighttime localizations to provide adequate data for the K-S test. The swimming speed of the tagged blue runner at night ranged from almost zero body lengths/s (bl/s) up to 20 bl/s (individual fish means of 0.56 m/s to 1.21 m/s; 1.97 bl/s to 4.12 bl/s). Fish 33800 (Fig. 4.13) and Fish 34000 (Fig. 4.14) were found to demonstrate the entire range of speeds on each night, which is illustrative of the behavior seen by all other fish. The fish could be found swimming at 0-2 bl/s more often than at any other speed. For example, fish 33800 was detected swimming between 0-2 bl/s 2,316 times, while it was detected swimming 2-4 bl/s only 803 times with the higher speeds found in decreasing numbers (Fig. 4.14). Fish 34000 was detected swimming between 0-2 bl/s 13,892 times, while it was detected swimming 2-4 bl/s only 5,661 times and again with the higher speeds found in decreasing numbers (Fig. 4.15). More plots showing the swimming speeds of blue runner in 2005 can be found in Appendix G.

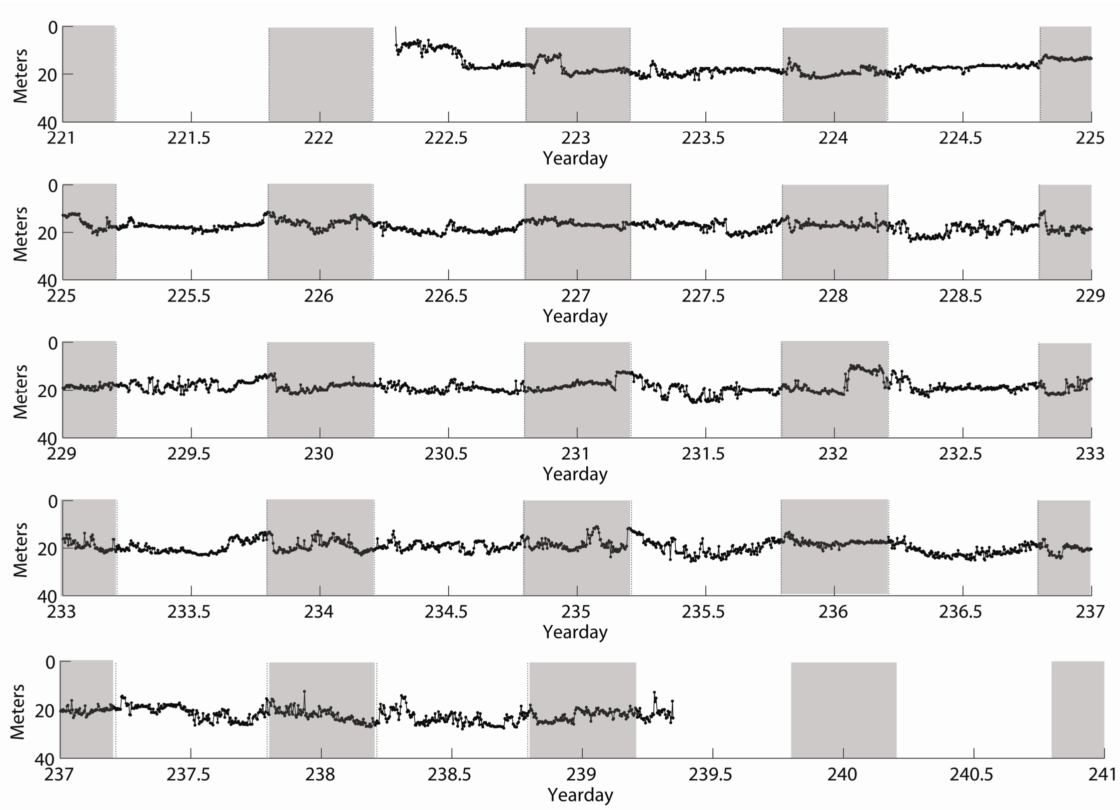

Figure 4.9. The day and night vertical distribution of Fish 34000 in 2005 are represented with the shaded areas indicating nighttime. The data are binned into 5 minute intervals.

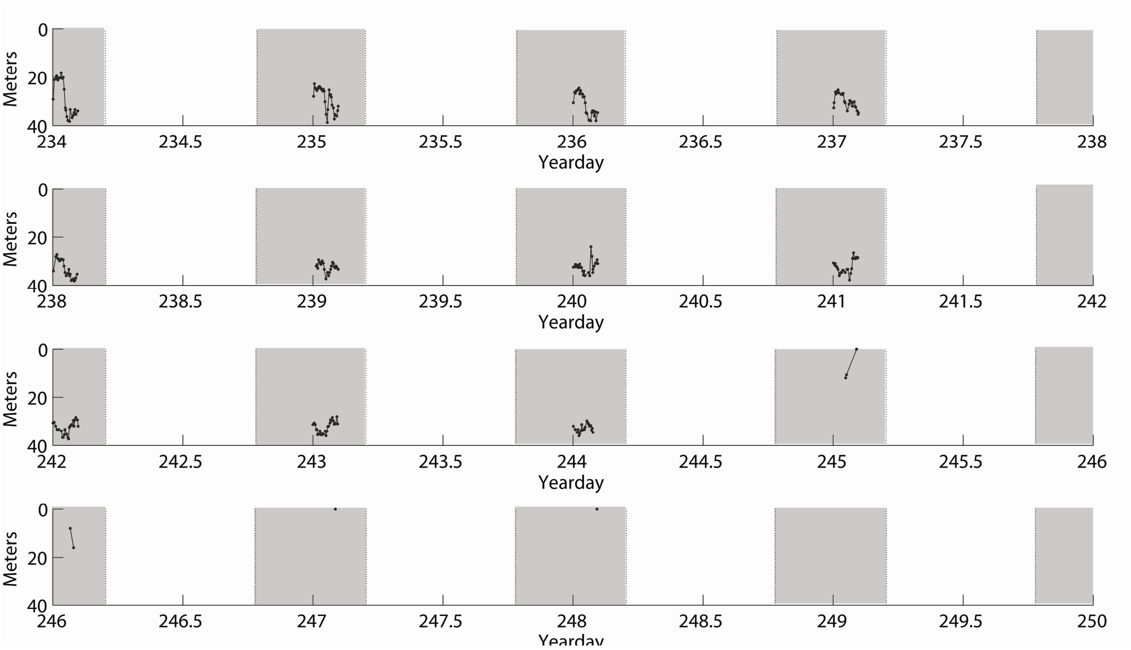

Figure 4.10. The day and night vertical distribution of Fish 30900 at ST151K in 2006 are represented with the shaded areas indicating nighttime. The data are binned into 5 minute intervals.

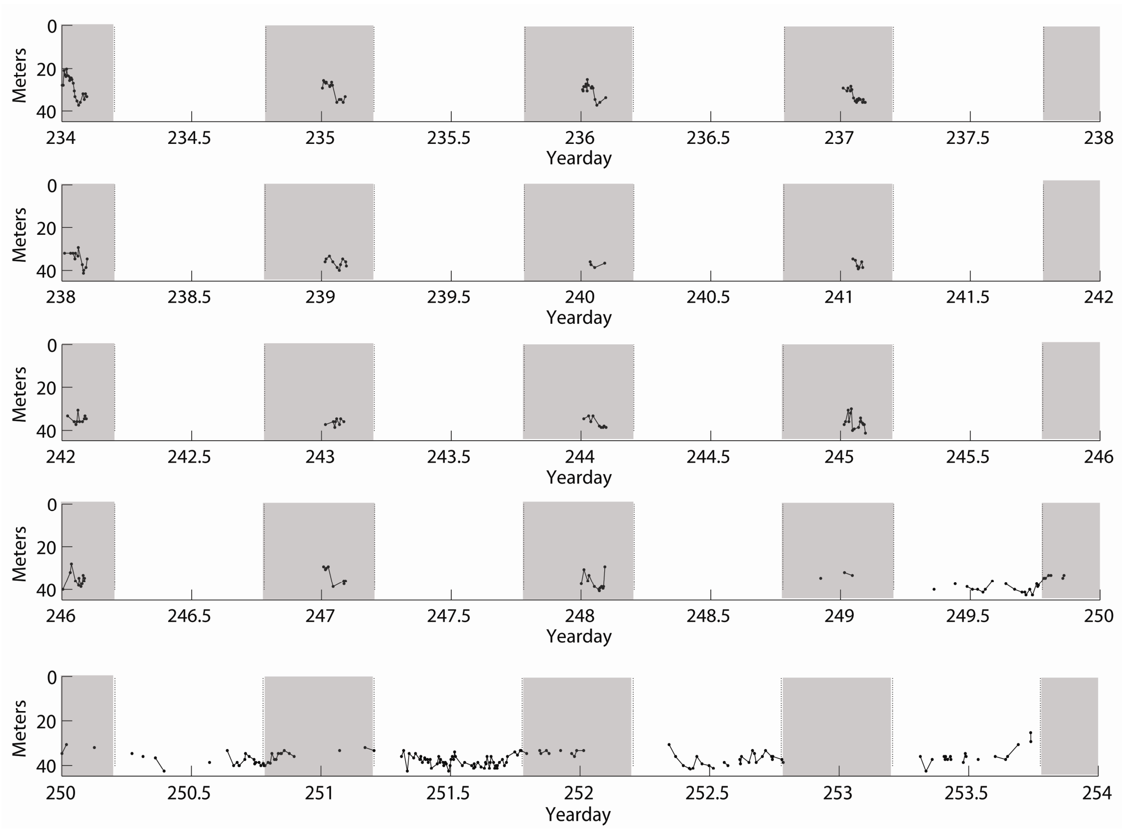

Figure 4.11. The day and night vertical distribution of Fish 35100 at ST151k from day 234 – 249 and then at the main complex for the remainder of the study period in 2006 are represented with the shaded areas indicating nighttime. The data are binned into 5 minute intervals.

Table 4.4. A two-tailed t-test (α=0.05) was run on the depths of each fish comparing their day and night vertical distributions in September – October 2006. All fish showed a strong significant difference in their depth distributions, except Fish 30900 which had no daytime detections during the study period.

Fish ID	***t-value***	***p-value***	***Fish ID***	***t-value***	***p-value***
30900	*	*	35700	-3.03	0.003
34800	-10.77	<0.0001	35900	-18.74	<0.0001
34900	-12.65	<0.0001	36100	-1.73	0.094
35100	13.43	<0.0001	36400	-0.61	0.601
35300	16.16	<0.0001	36500	0.43	0.669
35500	-27.26	<0.0001	36800	-6.24	<0.0001
35600	-17.51	<0.0001			

4.3.4 Nocturnal Distribution

The nocturnal locations of fish relative to platforms were highly variable and difficult to characterize. Based on examination of nighttime two-dimensional localization points plotted in relation to the platform locations, there appear to be two general patterns. Some of the fish preferred to remain near a particular platform at night, such as Fish 32500 which remained primarily near G-Deck platform (Fig. 4.17) and Fish 33500 which remained primarily near Yankee platform (Fig. 4.18). In other cases, fish could be found throughout the complex at night. Fish 33300 (Fig. 4.19) and Fish 33800 (Fig. 4.20) were typical of this type of nocturnal distribution. More plots showing the nocturnal distribution of blue runner can be found in Appendix G. A single factor ANOVA was run to test for a difference in the distance between the fish and the platform centers. All but one fish (Fish 31600) showed a statistical difference ($p<0.05$) in the nighttime distance from the centers of the platforms suggesting the fish showed a preference for a particular platform (Table 4.7).

Table 4.5. Mean ascent and descent rates of 31 of the 32 fish tracked during the 2005 study period (August 5 – 29, 2005). Insufficient data was available to calculate the rates for Fish 31600.

Fish ID	***Mean Rate of Ascent (cm/s)***	***Mean Rate of Descent (cm/s)***	***Fish ID***	***Mean Rate of Ascent (cm/s)***	***Mean Rate of Descent (cm/s)***
29500	3.04	0.83	32700	0.34	0.20
30100	0.31	0.31	32900	0.48	1.14
30200	0.90	0.37	33000	0.64	0.36
30500	0.59	1.03	33200	0.45	0.29
30600	1.22	0.21	33300	3.22	0.22
30800	3.34	0.43	33500	1.06	0.87
31200	4.17	0.17	33600	0.18	0.48
31300	1.31	1.38	33700	0.18	0.37
31400	0.24	0.34	33800	0.40	0.39
31500	0.17	0.23	34000	0.22	0.48
31600	-----	-----	34200	0.43	0.19
31800	2.54	1.86	34300	0.19	1.43
32100	1.12	0.48	34600	1.74	0.46
32300	0.56	0.77	34800	0.21	0.32
32400	1.19	0.07	34900	1.56	0.40
32500	0.58	0.19	35000	0.30	0.63

4.4 Discussion

4.4.1 Vertical Distribution

Blue runner were found to make significant vertical migrations through the water column during the dawn and dusk hours. The depths at which blue runner could be found were generally deeper during the night than during the day, though fish did make vertical excursions during both day and night throughout both study periods. Blue runner were conspicuously absent from the upper 10 m of the water column and exhibited a broader range of vertical movement in the water column at night than during the day. The pattern of moving up and down through the water column is similar to that noted in skipjack tuna (Schaefer and Fuller, 2007). This behavior could be related to feeding and/or predator avoidance.

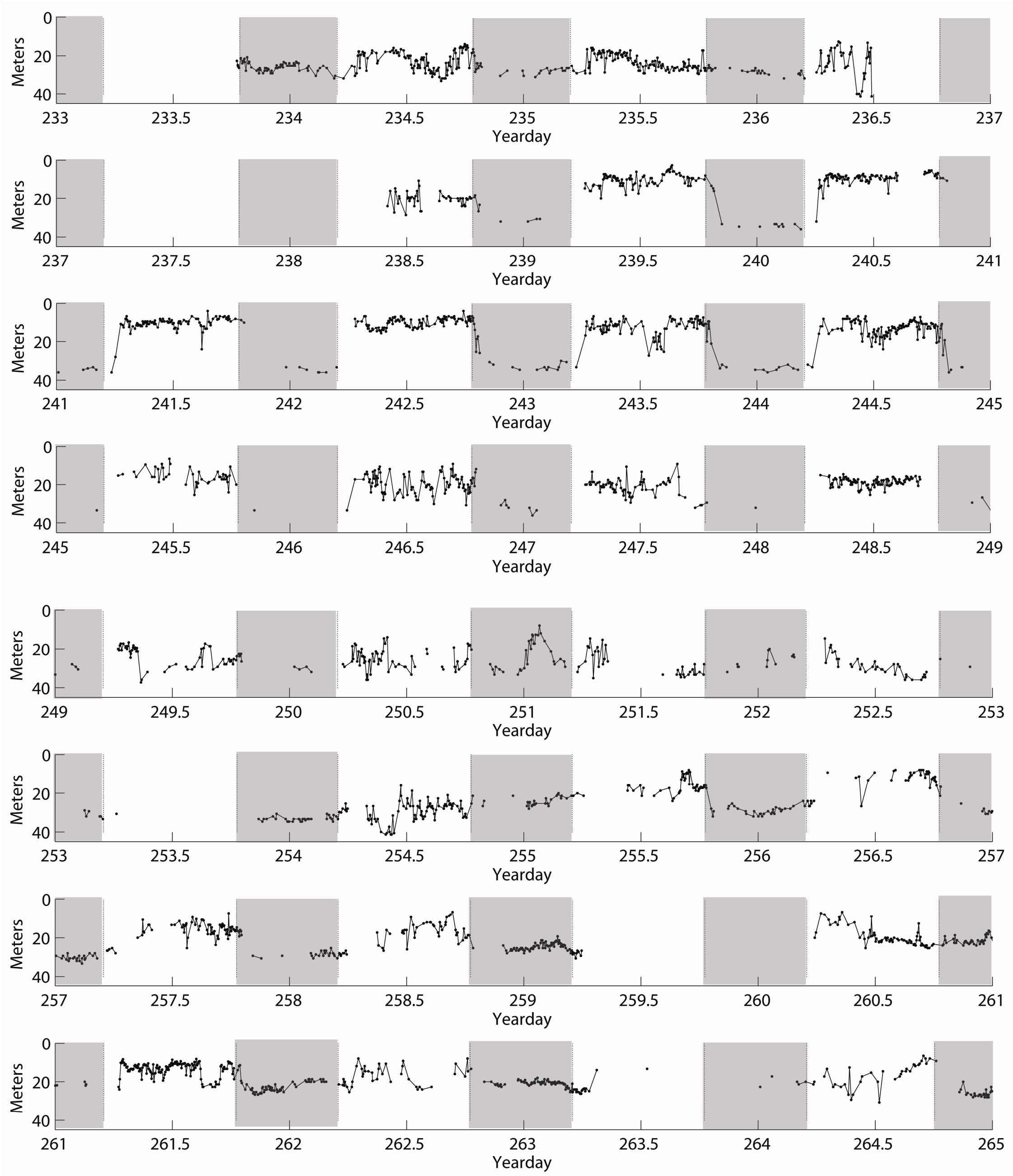

Figure 4.12. The day and night vertical distribution of Fish 35500 at the main complex in 2006 are represented with the shaded areas indicating nighttime. The data are binned into 5 minute intervals.

By remaining at depth the blue runner could avoid visual predators, such as barracuda. While predation may be a source of mortality for the tagged blue runner, it may also be the cause of atypical vertical migration patterns . If a tagged fish were consumed by a larger predator, the tag would likely remain in the digestive system of the predator until it is passed. During this time it would continue to transmit however its data would reflect the movement patterns of the predator. Such an instance may be indicated by Fish 30900 in 2006 when after ten days of only being seen at the deepest part of the water column, the depth readings from the tag indicate the fish was near the surface (Fig. 4.10). This is likely due to the tag being in the stomach of a predator. Fish 34000 in 2005 appears to show very little vertical migration, atypical of the behavior exhibited by the majority of the tagged blue runner (Fig. 4.9). This is the type of atypical behavior that would be expected from a fish that had been consumed by another fish. Due to the length of time that the tag continued to transmit varying depths (i.e. not at the bottom) it is unlikely that this fish was consumed by another, because the tag did not give data consistent with expulsion. It is possible that Fish 34000 demonstrated atypical blue runner movement patterns.

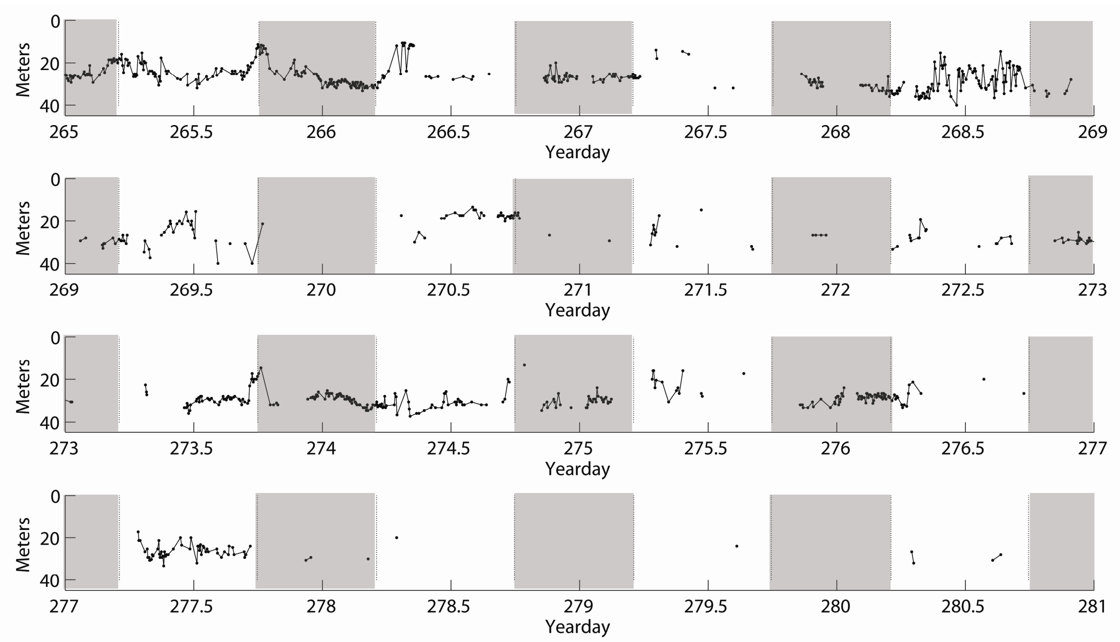

Figure 4.12 (continued)

At night blue runner were typically found just below 20 m but excursions into the 10-20 m depth strata were not uncommon. Keenan et al (2007) measured the artificial light field supplied by the platforms extended about 20 m into the water column. Figures

4.9 – 4.15 show the depth distribution of tagged blue runner during the study periods (2005 and 2006). Given the relatively large eye size of blue runner it is feasible that they could visually forage at depths below 20 m in the areas of high illumination provided by the manned platforms. Keenan et al (2003) showed that blue runner feed both day and night. The preferred food item during the night hours was larval fish, which previous studies have shown tend to exhibit a diel vertical migration pattern (e.g. Anderson et al 2007, Borges et al 2007, Rodriguez et al 2006). The light bowl provided by the lighted platforms would likely offer the blue runner an opportunity to forage in the upper depth strata of the water column which was not available at the unlighted satellite platforms. By remaining just below the light bowl the blue runner could avoid visual predators but not expend too much energy migrating up and down through the water column to feed on larval fish. ADCP data taken during the 2006 study shows that backscatter remains high in the upper levels of the water column into the night hours (Fig. 4.21). In 2006 the tagged blue runner at the unmanned platforms were found significantly deeper in the water column at night when compared with those found at the manned platforms of the main complex.

4.4.2 Nocturnal Swimming Behavior

Fish exhibit three types of swimming: critical – long duration (hours) swimming at a slower speed; burst – medium duration (minutes) swimming at a moderate speed; and sprint – short duration (seconds) swimming at very high speeds. The trade-off hypothesis suggests that a fish cannot equally demonstrate more than one of these swimming behaviors. Reidy et al (2000) found this theory is not always applicable and showed that Atlantic cod was able to perform well in both critical and sprint swimming tests. A large proportion of the fishes nighttime swimming was found to be in the 0-2 bl/s speed with small numbers of recordings being in the sprint speeds of 16-20 bl/s (e.g. Figs. 4.18 and 4.19).

Table 4.6. Results of Kolomogorov-Smirnov tests comparing day and night swimming speeds for 32 blue runner over the entire 2005 study period. All fish, except Fish 31600, had a significantly different distribution of swimming speeds during the day and night. Fish 31600 did not have enough night time data to perform the K-S test.

Fish ID	***Z-value***	***p-value***	***n***	***Fish ID***	***Z-value***	***p-value***	***n***
29500	30.53	<0.01	30,782	32700	11.58	<0.01	13,596
30100	4.94	<0.01	5,647	32900	11.37	<0.01	93,080
30200	26.89	<0.01	21,007	33000	4.28	<0.01	28,003
30500	29.40	<0.01	19,720	33200	11.19	<0.01	5,740
30600	34.37	<0.01	43,814	33300	8.06	<0.01	98,010
30800	9.70	<0.01	80,271	33500	19.84	<0.01	52,301
31200	10.48	<0.01	9,444	33600	1.52	<0.01	3,704
31300	11.45	<0.01	47,492	33700	4.80	<0.01	96,373
31400	2.17	<0.01	5,401	33800	29.46	<0.01	90,239
31500	15.08	<0.01	12,191	34000	3.90	<0.01	69,836
31600	-----	-----	-----	34200	18.81	<0.01	40,721
31800	18.41	<0.01	137,005	34300	14.15	<0.01	61,741
32100	13.79	<0.01	107,220	34600	17.50	<0.01	127,777
32300	5.38	<0.01	2,753	34800	20.73	<0.01	91,176
32400	2.08	<0.01	2,802	34900	13.68	<0.01	73,190
32500	15.13	<0.01	22,957	35000	10.72	<0.01	20,598

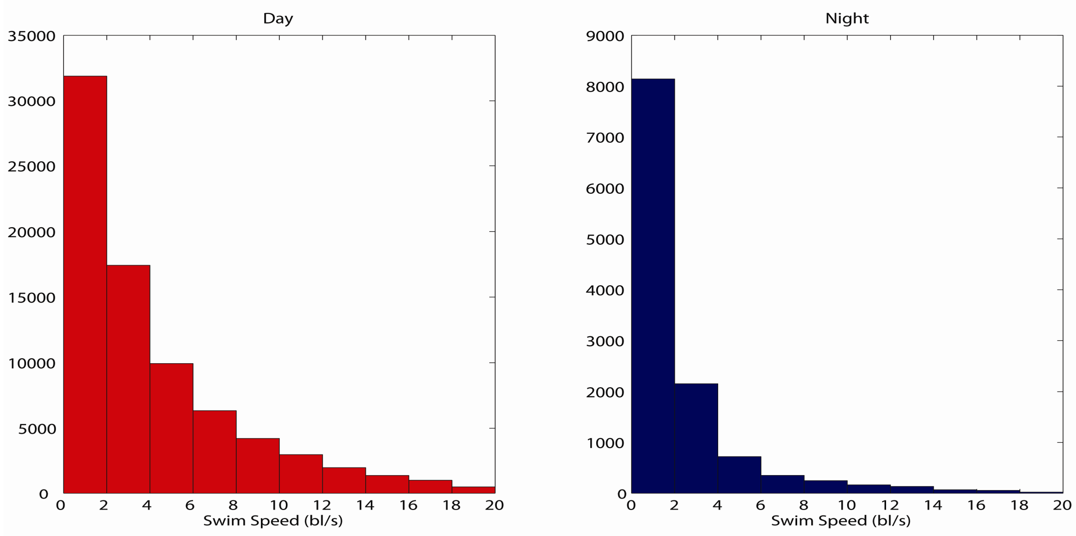

Figure 4.13. The daytime and nighttime swimming speeds (body lengths/second) of Fish 33800 are plotted over the course of the study period (August 8 – 27, 2005).

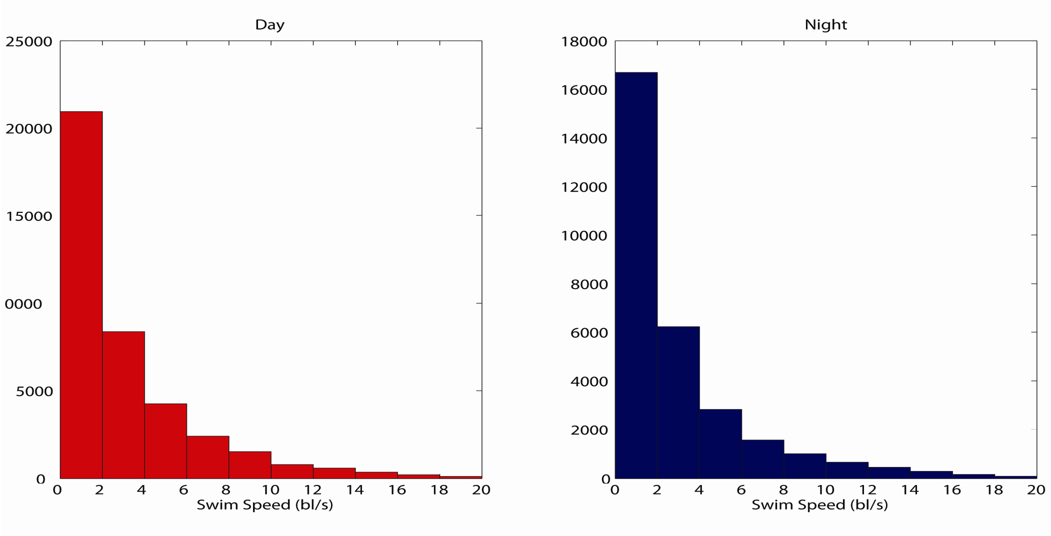

Figure 4.14. The daytime and nighttime swimming speeds (body lengths/second) of Fish 34000 are plotted over the course of the study period (August 9 – 27, 2005).

Table 4.7. A single factor ANOVA (α=0.05) comparing the distance of each fish from the two-dimensional center of each of the six platforms at the ST151 complex in August 2005 was run to determine if the fish utilized each platform equally at night. The F-values and p-values are presented in this table showing a strong significant difference in the utilization of the platforms for all fish.

Fish ID	***F-value***	***P-value***	***Fish ID***	***F-value***	***P-value***
29500	9975.88	<0.01	32700	9429.39	<0.01
30100	28296.39	<0.01	32900	8137.87	<0.01
30200	110138.69	<0.01	33000	2278.75	<0.01
30500	18663.01	<0.01	33200	2695.88	<0.01
30600	18883.32	<0.01	33300	4253.43	<0.01
30800	14125.38	<0.01	33500	35369.74	<0.01
31200	7264.80	<0.01	33600	2174.64	<0.01
31300	22849.89	<0.01	33700	5862.95	<0.01
31400	12646.97	<0.01	33800	6028.31	<0.01
31500	27194.27	<0.01	34000	26425.03	<0.01
31600	1.67	0.141	34200	11430.28	<0.01
31800	24619.90	<0.01	34300	6383.54	<0.01
32100	4848.37	<0.01	34600	35804.59	<0.01
32300	169319.80	<0.01	34800	6371.48	<0.01
32400	153.08	<0.01	34900	6099.37	<0.01
32500	7378.18	<0.01	35000	11095.31	<0.01

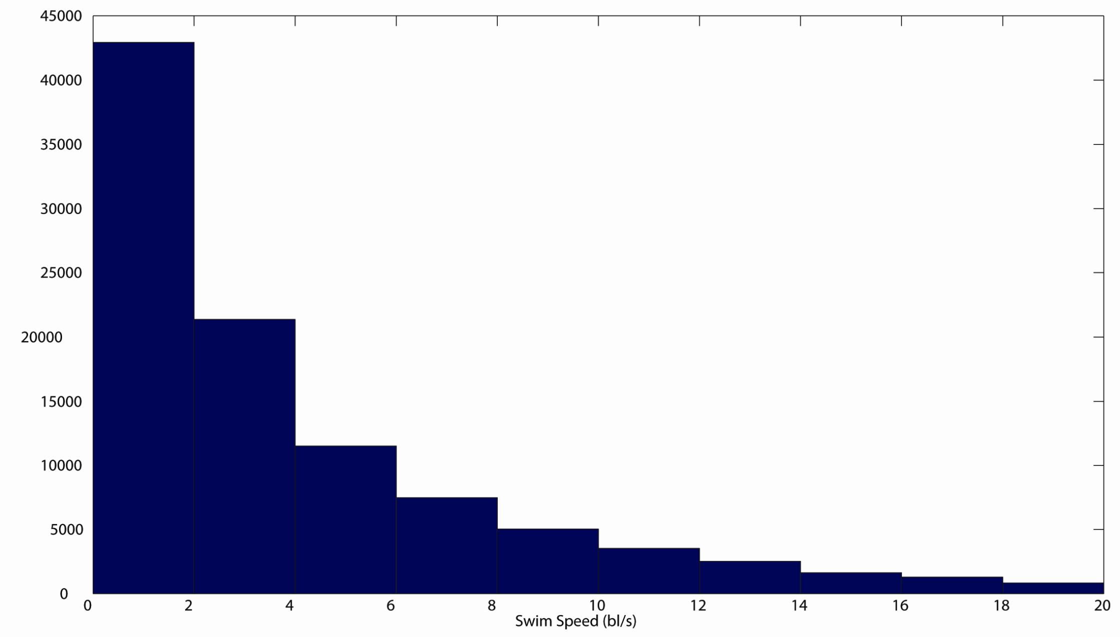

Figure 4.15. The cumulative swimming speeds (body lengths/second) for Fish 33800 are plotted for the entire study periods (August 8 – 27, 2005).

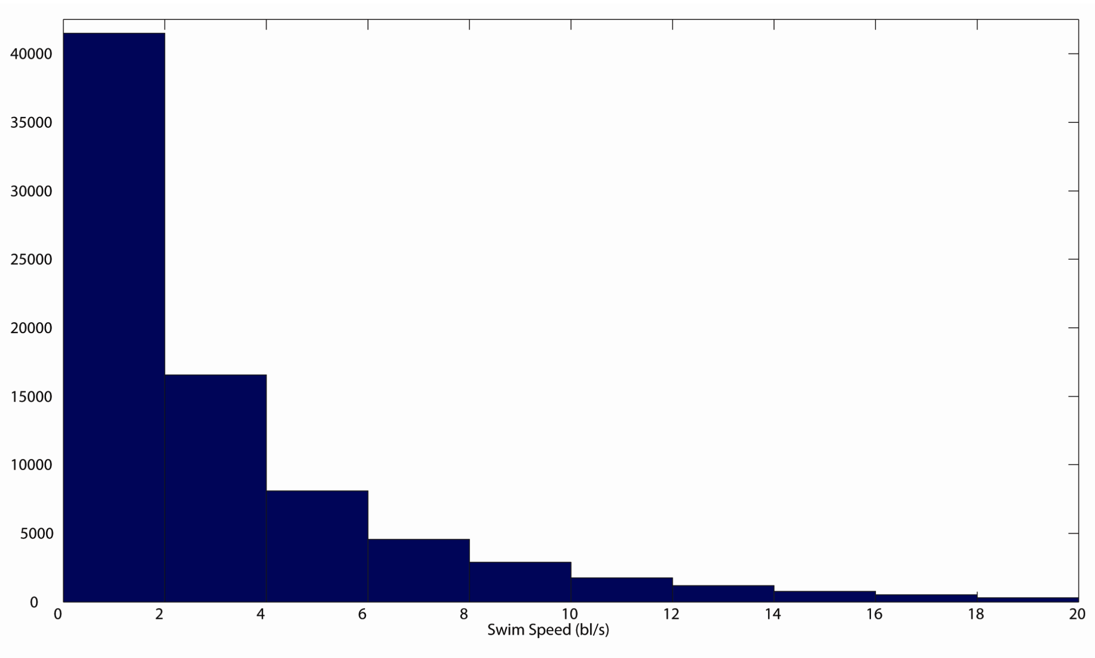

Figure 4.16. The cumulative swimming speeds (body lengths/second) for Fish 34000 are plotted for the entire study periods (August 9 – 27, 2005).

The higher speeds are found in periods of what Bailey et al (2003) call "fast starts." These fast starts are found when fish are exhibiting escape or attack behaviors. The distribution of swimming speeds seen in Figures 4.18 and 4.19 are indicative of fish engaging in an ambush type of feeding behavior, which is characterized by long periods of slow movement followed by short bursts or sprints used to capture prey. The energetic requirements of burst or sprint activity are higher than those of the consistent slow movements found in foraging behavior. Blue runner, however, feed on larger prey items at night and are able to gain more energy from these food sources, which should offset the additional energy expenditure.

While the extra weight of the surgically inserted tag might be expected to affect the swimming behavior and speeds of the blue runner, tests using dummy tags have shown no effect on swimming speeds in Atlantic cod (Cote et al, 1999), pikeperch (Koed and Thorstad, 2001), rainbow trout, white perch (Mellas and Haynes, 1985) and Atlantic salmon (Thorstad et al, 2000). As such, it is likely the tags did not have a measurable effect on the swimming speeds of the blue runner.

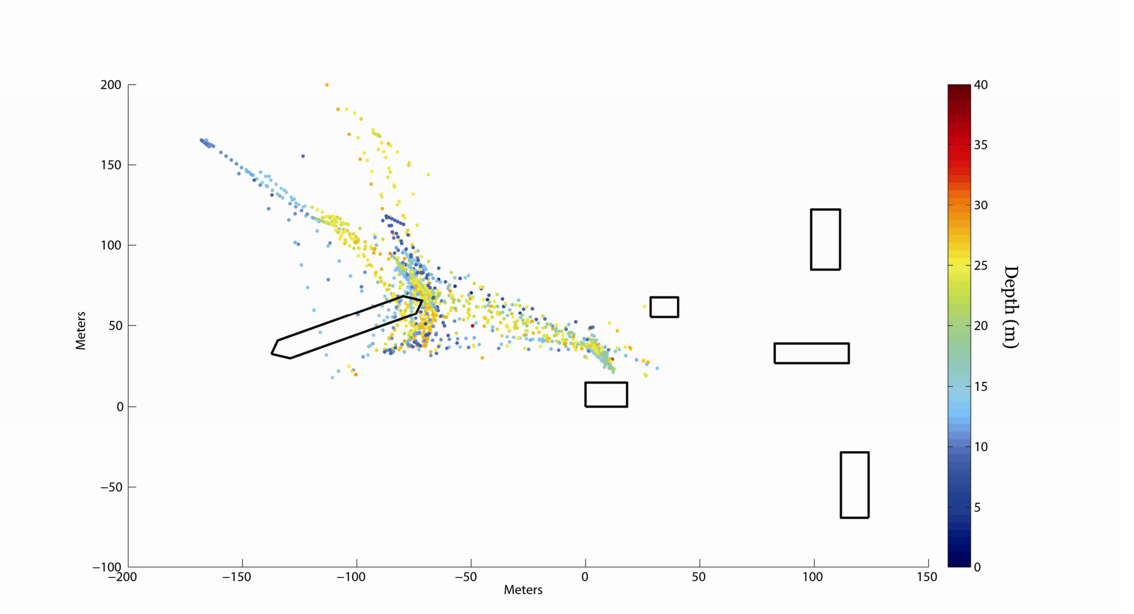

Figure 4.17. The nighttime location solutions of Fish 32500 during the entire study period (August 8 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

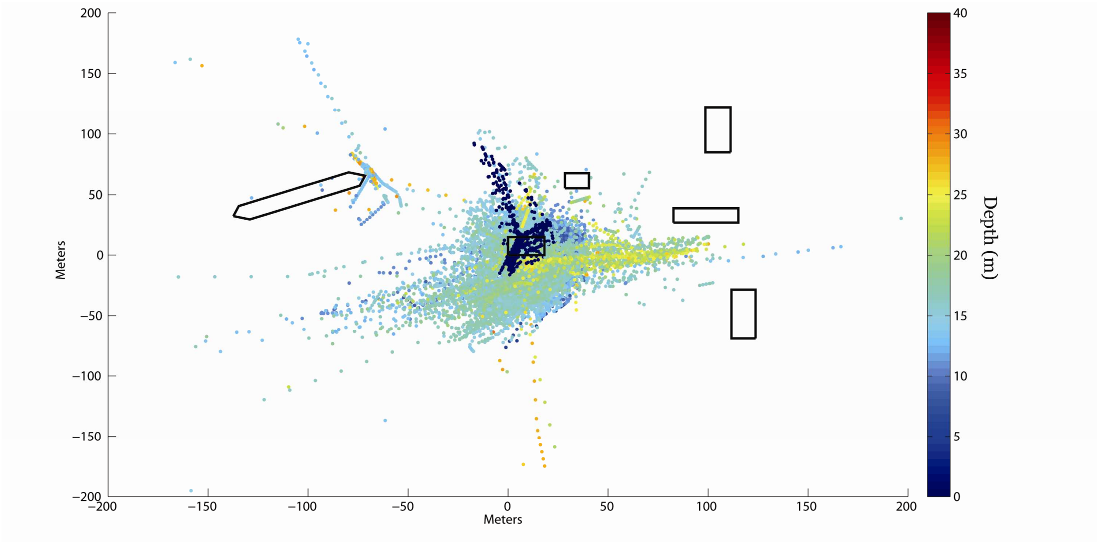

Figure 4.18. The nighttime location solutions of Fish 33500 during the entire study period (August 9 – 21, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

4.4.3 Nocturnal Distribution

The nocturnal distribution of blue runner observed at the ST151 complex demonstrates a great deal of spatial variability throughout the study period and from one fish to the other. While some fish tended to remain centered around a particular platform at night (Figs. 4.17 and 4.18) other fish showed no observable preference between the platforms (Figs. 4.19 and 4.22). The movement around the platform complex could be a result of two things. First, the fish could be moving away from the platforms to chase prey items. Second, the fish could be making excursions away from the platform complex to avoid predation by larger fish, such as amberjack. Mazur and Beauchamp (2006) used a visual foraging model to look at feeding in cutthroat trout at night in light-polluted Lake Washington and found that the prey abundance was not high enough to predict the amount of piscivory, but a more accurate predictor was the level of light pollution. Keenan et al (2007) measured the light field around the ST151 complex and found the bowl of light emanating from the manned platforms extended 100 m laterally from the light source. The large light field at the complex would allow for feeding forays away from the individual platforms and throughout the complex. Such feeding excursions would be at shallower depths the greater the distance from the platform light source. Given that most tag data that indicate that runner migrate downwards at night, it is more likely that excursions away from the platform may indicate predator avoidance behavior rather than active foraging.

Since the large light field would also help make the blue runner visible to other visual predators, any movement into the halo of light near platforms would be a trade-off between the increased opportunity to feed and the increased visibility to predators. Visual observation of blue runner behavior during the daylight hours revealed the escape behaviors seen when a predator approaches the space immediately around a fish or school of fish. The fishes quickly move away from the predator, generally in the direction of a platform, and may or may not rejoin the school they were in before fleeing. This flight behavior could also explain some of the movement to and from the platforms seen at night as fish venture away from the platforms to forage and return to the structure for shelter.

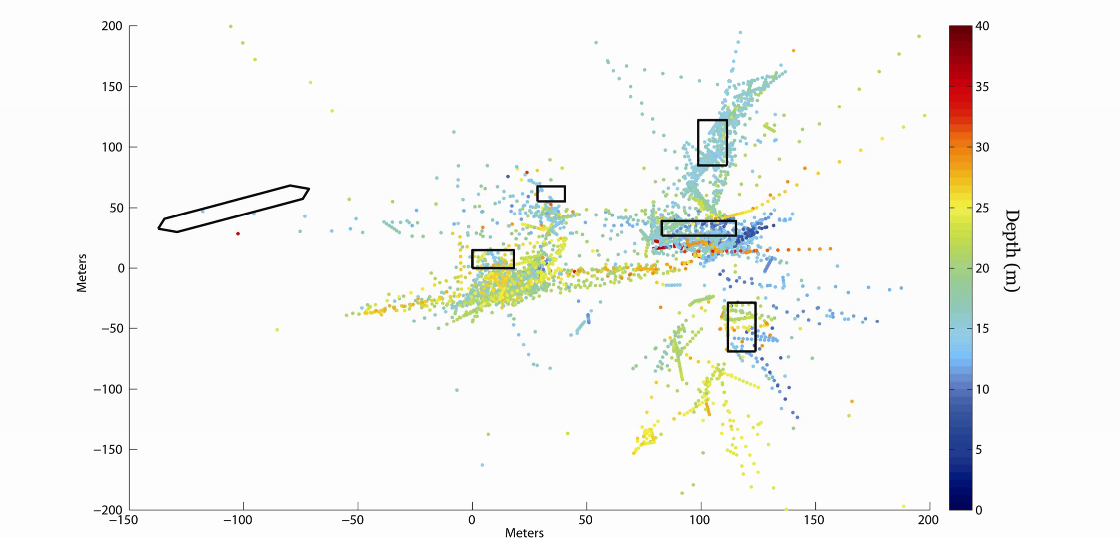

Figure 4.19. The nighttime location solutions of Fish 33300 during the entire study period (August 8 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

The research presented here demonstrates how the use of acoustic telemetry allowed for real time measurement of the swimming speed and observation of the behavior of a pelagic carangid. The distribution of swimming speeds seen by the tagged blue runner lends itself to the concept of ambush strategy of feeding, whereby an individual fish moves at a slow speed with only short bursts or sprints to capture larval fish and larger zooplankton.

Further study is needed to determine the spatial and temporal overlap of blue runner and their prey items at night. In addition laboratory experiments to verify the swimming speeds estimated in the wild would be helpful. Finally, determination of the energetic content of different prey items could be calculated to verify the idea that the ambush strategy of feeding provides a balance of energy expended and energy consumed.

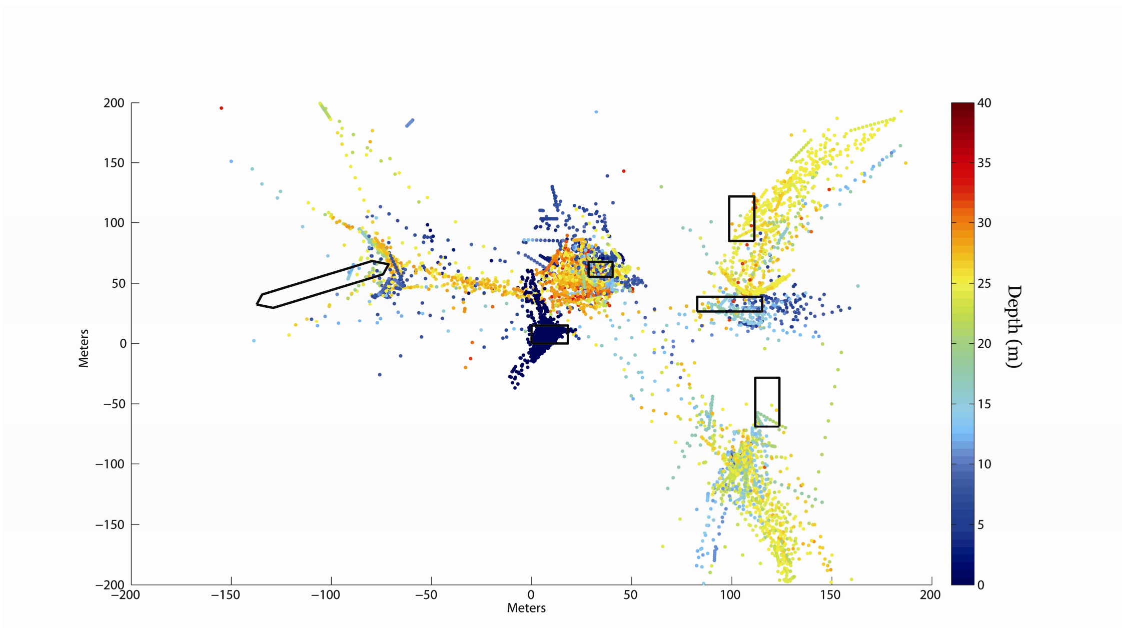

Figure 4.20. The nighttime location solutions of Fish 33800 during the entire study period (August 8 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

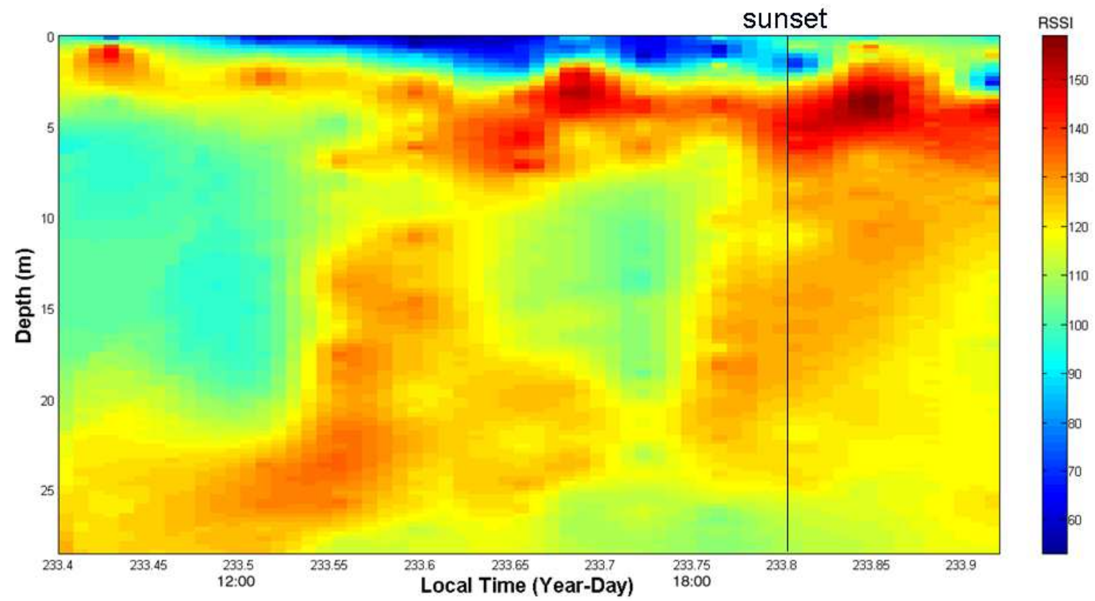

Figure 4.21. Data from ADCP casts during the 2006 study period show high levels of backscatter into the nighttime hours. RSSI is the received signal strength intensity, a measure of backscattering intensity.

4.5 Conclusions

This research has shown that *Caranx crysos* are mobile at night and do not spend a large portion of their time within the structure of the platforms. Some of the tagged fish tended to remain around a particular platform at night with short excursions away from the structure, while others were more motile and moved throughout the platform complex area. These excursions could be for the result of predator avoidance or to increase the area of feeding.

In addition to horizontal movement around the platform complex, a large degree of vertical movement by the tagged fish was seen at night. The use of acoustic tags allowed for a precise determination of the vertical movements of the blue runner. The blue runner were primarily found below 20 m depth at night with occasional forays into the upper 10 m of the water column. The fish tend to remain in an area where they can stay out of visual contact of predators except for when they may be following prey items to the upper depth strata of the water column.

The distribution of swimming speeds demonstrated by the tagged blue runner lends itself to the concept of ambush strategy of feeding, whereby an individual fish moves at a slow speed with only short bursts or sprints to capture larval fish and larger zooplankton. Further study is needed to determine the spatial and temporal overlap of blue runner and their prey items at night. Finally, determination of the energetic content of different prey items could be calculated to verify the idea that the ambush strategy of feeding provides a balance of energy expended and energy consumed.

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CHAPTER 5
CONCLUSIONS AND POTENTIAL AVENUES OF FURTHER RESEARCH

5.1 Summary of Research Findings

The research presented in this dissertation is the first example of the use of acoustic telemetry to measure the home range and *in situ* behavior of pelagic fishes around petroleum platforms. Blue runner (*Caranx crysos*) were tracked in, and around petroleum platforms in the Gulf of Mexico for up to 23 days in 2005 and up to 58 days in 2006. The data from this study indicate that blue runner exhibit site fidelity and establish a home range in the presence of artificial structure.

5.1.1 Home Range

Blue runner were closely associated with petroleum platforms in August 2005, and some fish displayed limited site fidelity for particular parts of the platorm complex which persisted for up to seven days. As no long range excursions were detected to the satellite platforms, the manned platforms appeared to be the preferable habitat during the study period. No significant difference was noted in the size of day versus night home ranges. Since blue runner were found to feed both day and night by Keenan *et al.* (2003), it is likely they are active and mobile during the night and foraging within the light field provided by lighted, manned platforms.

5.1.2 Spatial Movements

The broad scale movements of blue runner were investigated in 2005 and 2006. No long range movement was detected by the sentry hydrophones mounted at the unmanned satellite platforms in 2005. However, in 2006, tagged fish were caught and released at different platforms and all but one of the fish released at the satellite platforms moved to, and remained at, the main complex. This behavior further demonstrates the strong site fidelity exhibited by blue runner.

5.1.3 Estimation of Blue Runner Schooling Dimensions

The spatial dimension of blue runner schools in 2005 was estimated to be a maximum of 36m. This upper threshold was based on observations of inter-fish distances during a subset of the study period. While most schooling events were of short duration, one school was documented to persist for more than 5.5 hours. Tagged fish could be found in four distinct schools present at the same time. The blue runner did not appear to exhibit a preference for any particular schools, but instead moved frequently among schools.

5.1.4 Diel Differences in Schooling Behavior

The individual blue runner exhibited different schooling patterns, with a greater frequency of schooling events seen during the day than at night. The light field at the ST151 complex may provide sufficient conditions for blue runner to continue to feed at night (Keenan *et al.* 2007) and likely contributes to the difference in schooling patterns over the diel cycle. The location of fish within the platform structures at night may be an aggregation by individuals seeking refuge from nocturnal predators rather than coordinated schooling events.

5.1.5 Swimming Speeds

The burst swimming speeds of blue runner in 2005 was measured at 18 bl/s, which is more in line with the speeds measured for yellowfin tuna (Blake 2005) and wahoo (Bond 1996). While blue runner exhibited the capability for high burst speeds, they spent the majority of their time swimming at 1 bl/s or slower. The nighttime swimming speeds were significantly slower than those measured during the day. These slower swimming speeds could be indicative of passive (ambush) foraging. This research is the first known example of remote measurement of *in situ* swimming speed.

5.1.6 Diel Vertical Migration

The tagged blue runner were found deeper in the water column at night (20-30 m) than during the day (10-15 m). A pronounced vertical migration was seen, with a descent around sunset and an ascent around sunrise. The rate of ascent was faster than the rate of descent. No difference was found in the effects of time at liberty or moon phase on the rates of ascent and descent, but individual fish did exhibit different rates of ascent.

5.2 Fish Mortality

The rule of thumb in using surgical implantation of tags is for the tag to not exceed 2% of the out of water mass of the fish (Winter 1983). The tags used in this research weighed approximately 8g, giving a lower weight goal of 400g for fish to be tagged. The fish used in this research ranged from 375 – 747g. No significant correlation was found in the mass of the fish and the number of days tracked (r^2=0.05). Mortality from the surgery was still a concern. No studies were performed to determine the long term effects of surgical tag implantation on blue runner as part of this research. Previous studies on other fish have found that surgical tag implantation did not lead to higher mortality, though (Close *et al.* 2003 – Pacific lamprey; Cote *et al.* 1999 – Atlantic cod; Koed and Thorstad 2001 – Pikeperch; Mellas and Haynes 1985 – Rainbow Trout and White Perch).

Mortality of blue runner could be directly observed from the vertical distribution data in 2005 (e.g. Fish 32000, Fig. 5.1), though the mortality was not as apparent from the data in 2006. Of the 46 blue runner tagged in 2005, fourteen showed the same pattern of vertical distribution as seen in Figure 5.1, whereby the pressure reading from the tag rapidly increases until it reaches the water bottom and remains there for an extended period of time. This suggests either tagging-induced mortality of the fish or tag expulsion.

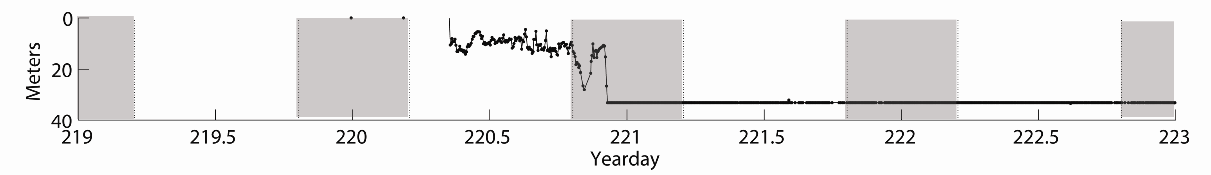

Figure 5.1. The vertical distribution of Fish 32000 in August 2005. The shaded areas indicate nighttime. The depth data indicates the fish died during the night of yearday 220, less than 24 hours following release.

While some fish simply died and sank to the bottom or expelled their tags, in a few other cases, mortality associated with predation by another species appears to be a possibility. For example, fish 31500 appeared to change its vertical migratory pattern to a holding a fairly constant mid-water depth on yearday 225 (Fig. 5.2). Thereafter receptions were fewer and ceased entirely by day 232. This pattern is consistent with ingestion of the fish by a predator and subsequent excretion of the tag. Another such case was observed in 2006 with fish 30900 (Fig. 5.3). For the first ten days the fish was tracked it remained at depth at night, but starting on the eleventh day (day 245) the tag indicated that the fish was up near the surface at night. This may have been indicative of predation whereby the tag was eaten as part of the blue runner and remained in the stomach of the predator over the next few days.

The largest number of fish present on a given day was 29 on August 12 and 13, falling to eighteen on the final day of study (August 27) giving a loss rate of 0.78 fish/day. Of the nineteen blue runner tagged in 2006, thirteen were tracked for at least 24 hours following release (Fig. 5.4). The depth data did not show the same patterns of fish mortality as in 2005. The largest number of fish present on a given day was thirteen (August 25) with only one fish remaining at the end of the study (October 10) for a loss rate of 0.26 fish/day (Fig. 5.5). It is interesting that the loss rates during 2006 were lower than in 2005. This may have been associated with the much shorter holding times used in 2006.

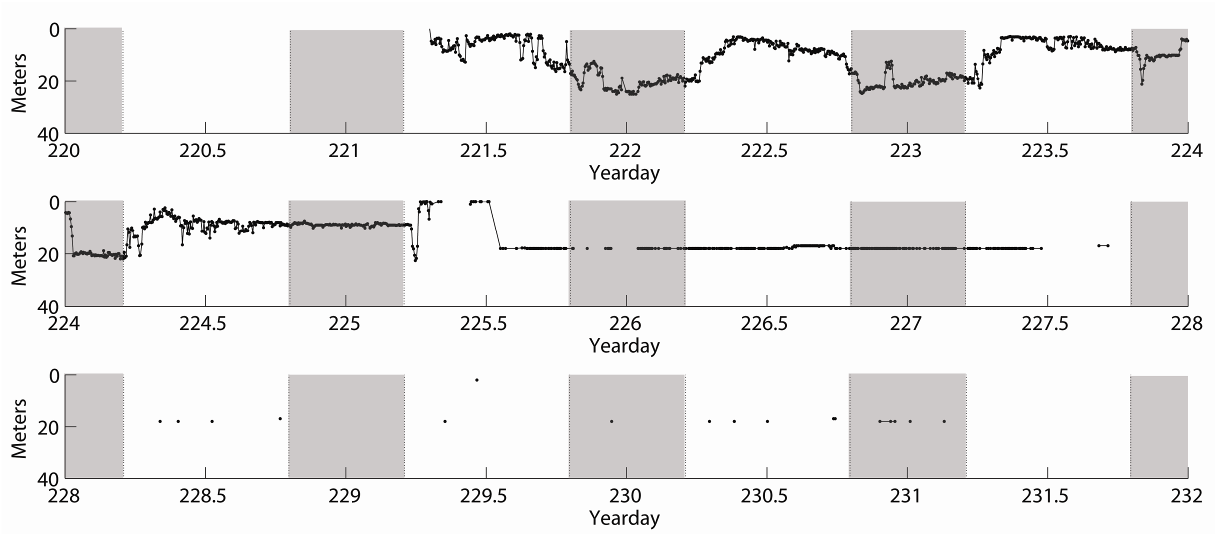

Figure 5.2. The vertical distribution of Fish 31500 over the study period in 2005, with nighttimes indicated by shading. Data is binned in five minute intervals.

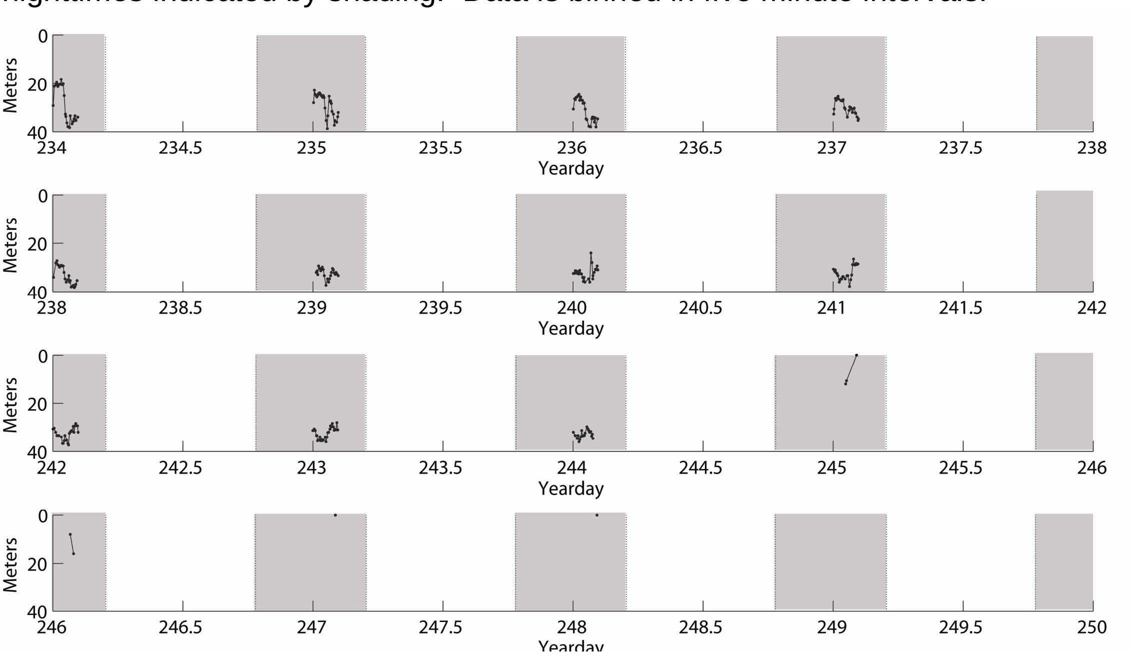

Figure 5.3. The day and night vertical distribution of Fish 30900 at ST151 K in 2006 are represented with the shaded areas indicating nighttime. Note the change in nighttime vertical distribution starting on day 245. Data are binned in five minute intervals.

When the mortality rates are subtracted from the overall loss rates, the results indicate a loss (straying beyond the coverage of any hydrophones) of 0.64 fish/day in

2005. The general absence of data on mortality in 2006 makes it difficult to distinguish straying from mortality.

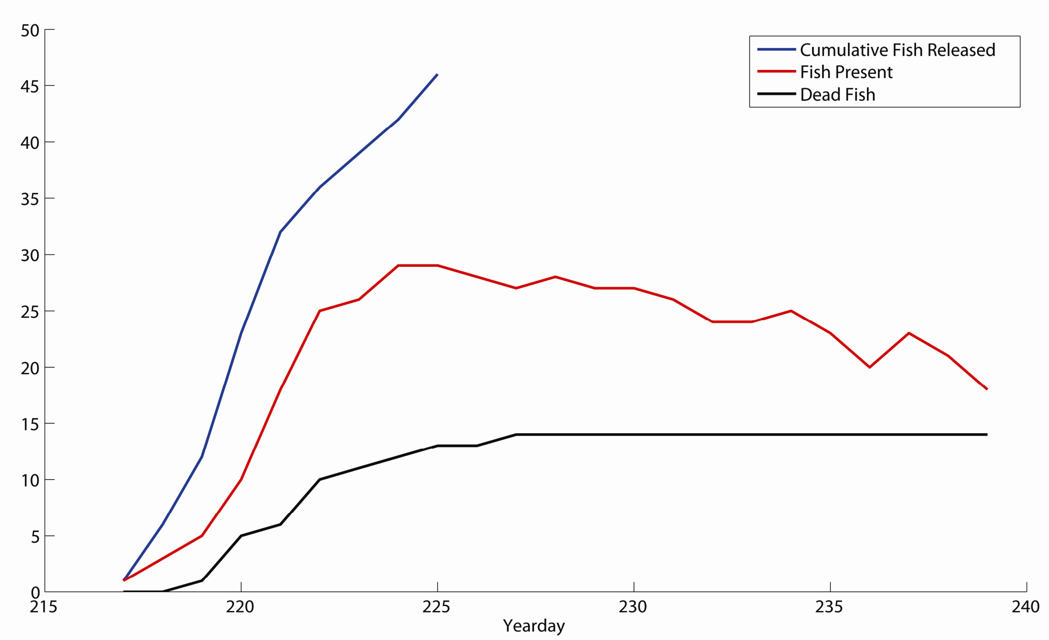

Figure 5.4. The cumulative number of tagged blue runner released, total number of tagged fish present on a given day and number of fish presumed dead based on depth data patterns.

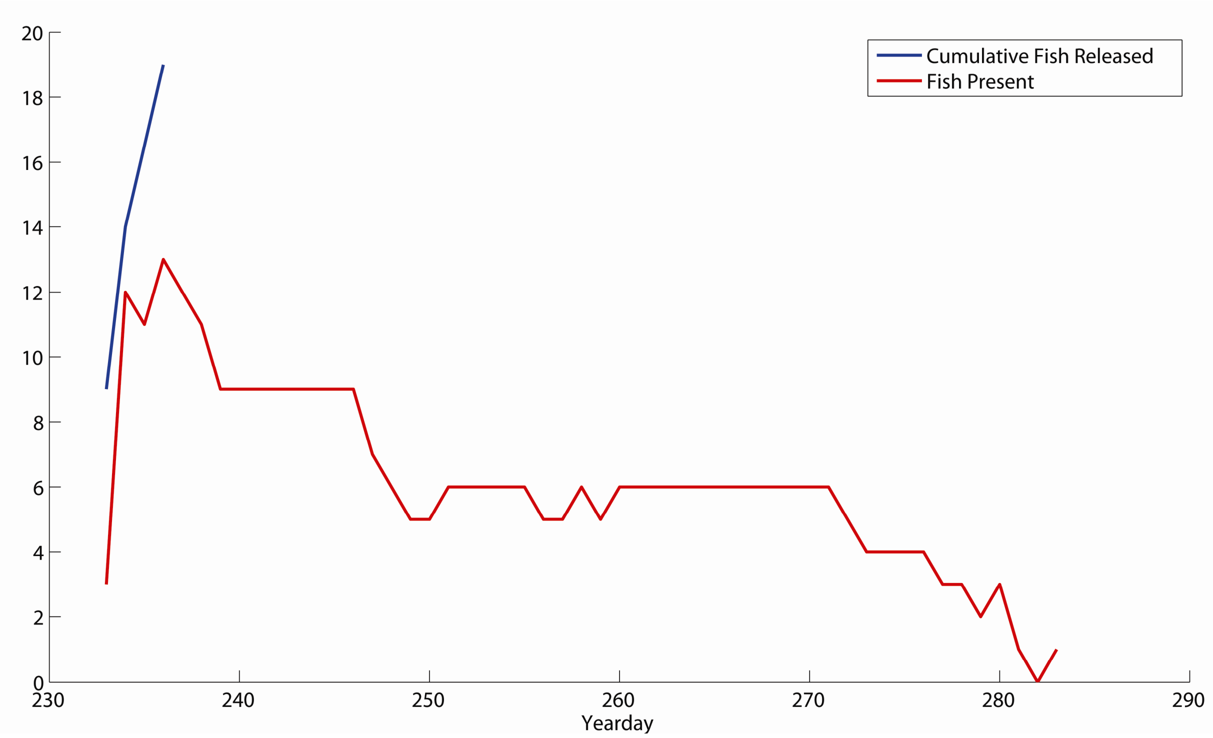

Figure 5.5. The cumulative number of tagged blue runner released at ST151K and the ST151 main complex and the number of fish present on each day in 2006.

5.3 Three-dimensional Movement

Most of the data analysis in this research treated the localization data as a two-dimensional construct (e.g. home range and horizontal distribution). The tags did transmit pressure data on alternating pings. The combination of the two-dimensional localization data with the depth estimate allows for three-dimensional tracking of the tagged fish. Unfortunately, currently-available home range estimation algorithms are not designed to calculate three-dimensional volumes. There is an inherent error associated with using the two-dimensional data without taking into account the depth of the fish. Based on a worst-case scenario (a tagged fish 350m from a hydrophone at 10m depth during the day and 25m depth at night) I estimated that the 2D position estimates have at the very most, an error of ±0.16 m during the day and ±1.04 m at night.

Using only two-dimensional data shows the horizontal location of the fish over time. Figure 5.6A is an example of the horizontal distribution of Fish 33800 over six hours on August 8, 2005. This encompasses a period of the day when the fish was undertaking a vertical migration from the surface to the deeper strata of the water column (Fig. 5.6B). Figures 5.6A and 5.6B only show part of the picture, however. When the depth data is combined with the 2D localization data, a clearer picture of the vertical descent can be seen (Fig. 5.6C). The fish did not make a direct descent from the surface, but instead meandered around the platform area while making its way down. The use of the MAP_600 system allows for a much more complete picture of the behavior of the tagged blue runner.

5.4 Challenges Associated with Acoustic Telemetry

Using acoustic telemetry in an area with a large amount of hard structure, such as the legs of the petroleum platforms, can lead to a problem associated with the acoustic signal reflection (multipath). This can lead to a miscalculation of the time differential of acoustic reception at different hydrophones, and thus lead to an imprecise position solution. Multipath is an inherent problem with these types or study areas, but one that is minimized through the use of larger numbers of hydrophones.

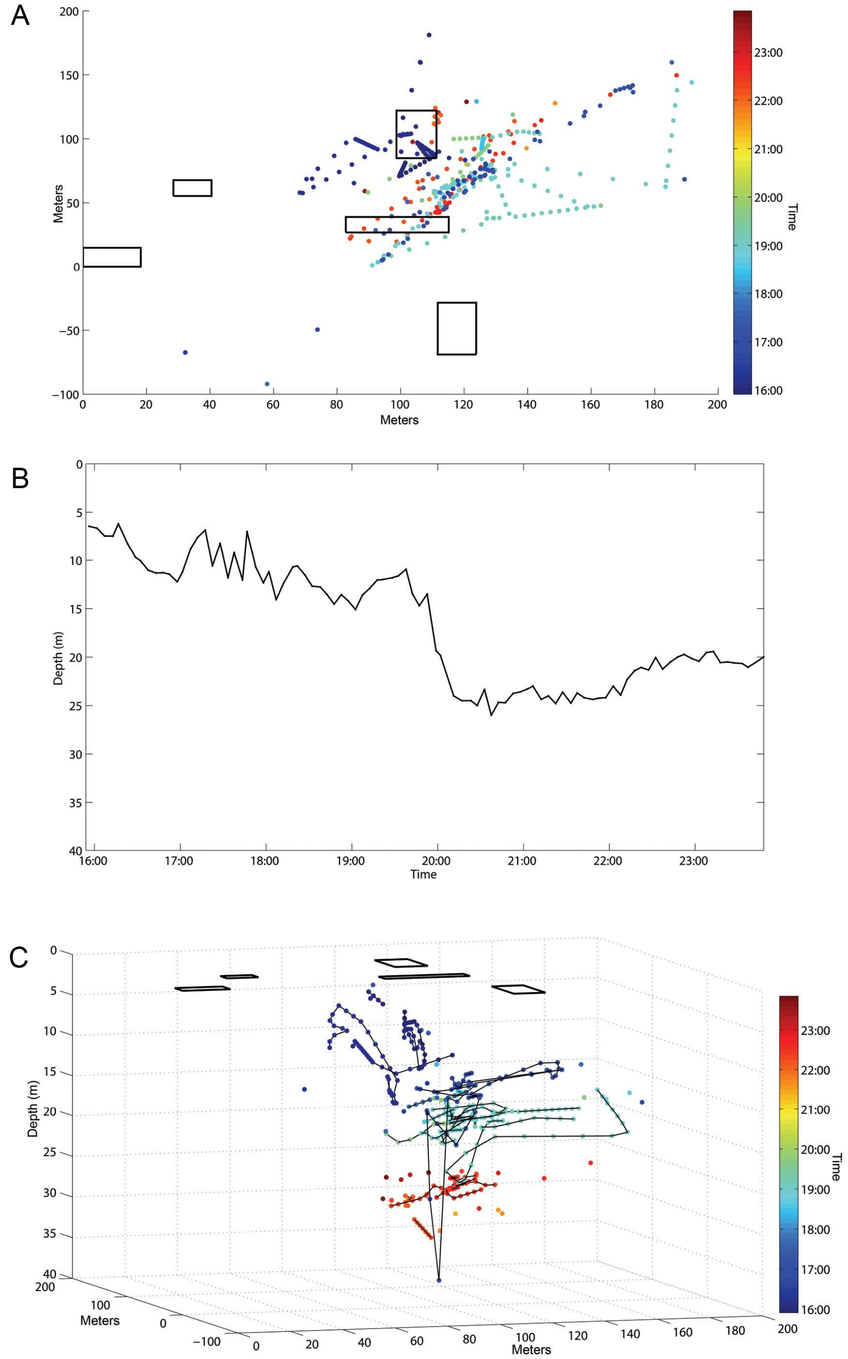

Figure 5.6. The synthesis of the 2D localization data (A) and the depth data (B) into a 3D representation (C) of the vertical migration of Fish 33800 on August 8, 2005.

In addition, the hard structure of the platforms may reflect some signals away from the hydrophones reducing the number of localizations. The detection envelope for the 2005 study period (Fig. 5.7) shows some hard edges, particularly to the northeast of G-Deck and southwest of the Production 2 platforms. This is likely due to interference from the legs of the platforms blocking the signal from the hydrophones.

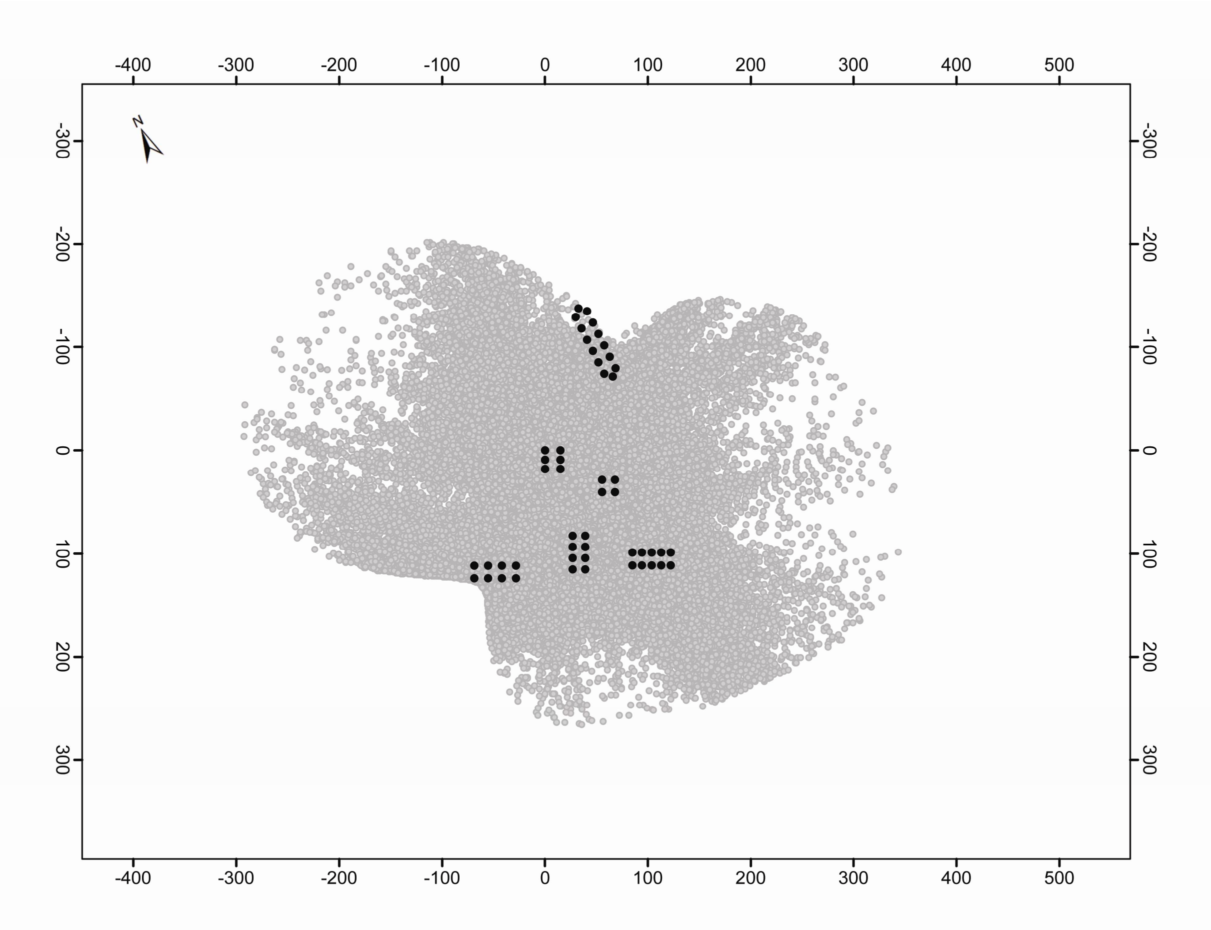

Figure 5.7. The totality of valid position solutions for the 23 blue runner tracked for more than seven days during the 2005 study period.

Another problem encountered in this study related to the difference in receptions between the day and night. During the daytime periods the blue runner tended to remain in the upper 10 -15 m of the water column, but descended below 20 m at night. This nocturnal distribution placed the blue runner below the pycnocline seen during the study period (Fig. 5.8). The pycnocline may have caused enough interference with the acoustic signal to reduce the number of viable position solutions.

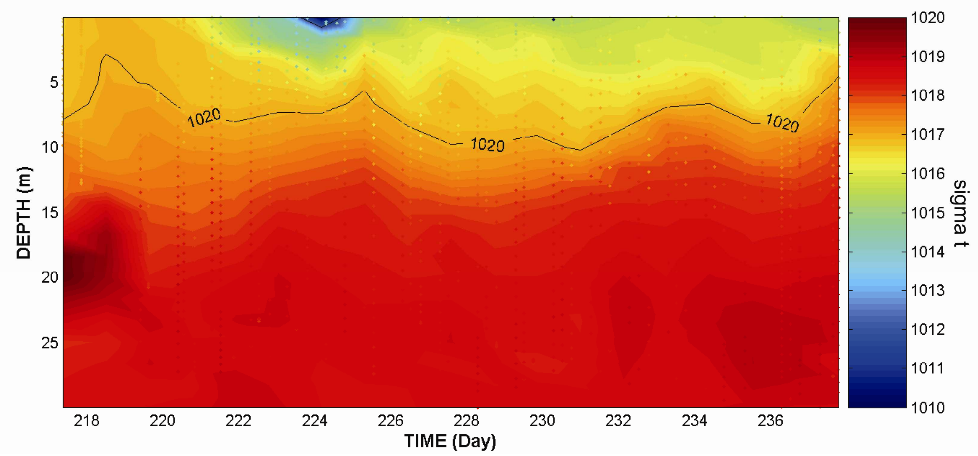

Figure 5.8. The density of the water column (sigma t) during the course of 2005 study period indicating a pycnocline between 10 and 15 m.

5.5 Attraction Theory versus Production Theory

The theories surrounding the use of artificial structures by pelagic fishes can be broken down into two major schools of thought – attraction and production. The basis of the attraction theory is that the hard structure of the artificial reef will attract fish to the region and increase the biomass of the reef. The production theory is associated with two hypotheses. The first involves the idea of providing a region for larval fish to settle, while the second hypothesis involves the structure of the artificial reef and its ability to provide refuge from predators and a concentrated food supply. A debate about which of these theories is correct has been ongoing for decades.

The data presented here suggests the use of petroleum platforms in the Gulf of Mexico by blue runner is likely a mix of the two theories. The sheer number of blue runner and the long range movement data suggests that the blue runner are attracted to the platforms, particularly to the lighted, manned platforms. The local increase in biomass can be seen as an example of the attraction theory.

The production theory suggests that the concentration of food and the availability of predator refuge is the reason for the high biomass at artificial structures. The large amount of food present in the area allows for increased foraging success for the blue runner around the platform. Nocturnal foraging within the halo of artificial lights provides an additional bioenergetic subsidy to blue runner around manned platforms. In addition, the galley on the main quarters platform at ST151 (Yankee platform) dumps the ground kitchen scraps into the water through a pipe which attracts large numbers of smaller fish to the area. The localization data indicates that blue runner do move in and out of the structure of the platforms. This movement is likely due, to some extent, to avoiding predation but may also reflect utilization of waste food. Thus it would appear that platforms provide enhanced production through illumination and discarded organic matter.

As the blue runner data from this study can be used to support both the attraction and production theories a comparison to past reviews is in order, particularly Grossman *et al.* (1997) and Powers *et al.* (2003). Grossman *et al.* (1997) looked at five situations where habitat could be limiting to fish and which could lead to an increase of fish biomass at artificial structures: 1) the relationship between habitat and abundance, 2) the reduction in available habitat, 3) the limitation of refuge, 4) the effects of recruitment on population size, and 5) resident removal studies. Of these five only situations 1 and 3 can be investigated here. Previous studies reviewed by Grossman *et al.* found a positive relationship between the amount of habitat availability and reef fish biomass and concluded that increases in habitat lead to increases in biomass (den Boer, 1978; Luckhurst and Luckhurst, 1978; Roberts and Ormond, 1987). Grossman *et al.* (1997) refute this as evidence of production because the studies did not require that habitat be a limiting factor and cannot fully explain the increase in fish biomass. The predominant substrate in the Gulf of Mexico is silty-clay and hard substrate is limited to oyster reefs which are sparsely located throughout. The platforms provide an estimated 50 km^2 of additional reef habitat (Gallaway and Lewbel, 1982). In addition Stanley and Wilson (1997, 1998) showed that fish biomass decreased as the distance away from Gulf platforms increased. The high biomass of blue runner and the persistence of the individuals at the platforms indicate some production advantage exist for fish at the platforms.

In situation 3 as looked at by Grossman *et al.* (1997) there exists a limitation of refuge. Previous studies found that it may be possible for an increase in refuge area to result in an increased abundance of fish (Bohnsack, 1982; Doherty and Sale, 1985; Hixon, 1991). While the clustering of platforms in the Gulf allows for an increase in the availability of refuge, the platforms still exist as isolated, or semi-isolated, refuges within the Gulf as a whole. This increase in refuge could be an example of the production theory. Grossman *et al.* (1997) stated that the local increase in biomass resulting from increased refuge demonstrated in the previous studies may not scale up to the regional level, and it is not clear if the biomass is controlled by refuge limitation or recruitment limitation. Therefore, the increase in biomass cannot be attributed solely to either the production or attraction theories.

Powers *et al.* (2003) studied attraction/production surrounding petroleum platforms utilizing three different scenarios. In the first scenario the increase in fish production is a result of aggregating fish that already existed in the system (attraction theory). In the second scenario adding artificial reef habitat increases recruitment, which is previously limited by habitat, or by increasing growth, which is previously limited by refugia (production theory). In the third scenario recruitment and growth are increased by the addition of artificial reef habitat, but expected increase in biomass is offset by the increase in fishing mortality.

Determination of what life stage(s) the blue runner migrated to the platforms is not possible with the data from this study, as only larger size individuals were collected. Larval forms of blue runner have been found during the summer months in the Gulf in previous studies (Ditty *et al.* 2004; McKenney *et al.* 1958). It is entirely possible that the larvae were growing and generating secondary production at another site and attracted to the site only as larger individuals. This would fall in to the first scenario of Powers *et al.* (2003) and support the attraction theory.

The second and third scenarios discussed by Powers *et al.* (2003) both include enhancement of the habitat due to the concentration of food and the increase of predator refuge as a result of the increase in artificial reef habitat. The site fidelity and home range establishment of the pelagic blue runner around the petroleum platforms indicate that a production benefit exists for the fish leading to an increase in biomass. Blue runner is used as a bait fish by recreational fishermen in the Gulf and the concentration of the blue runner schools around the platforms could lead to a higher fishing pressure on the species which could offset the biomass gains from the habitat enhancement.

The blue runner data presented here does not fully support either the attraction theory or the production theory. Instead, the data suggests the increase in biomass is likely due to a combination of the two mechanisms. There is no evidence that blue runner settle at the platforms as larvae or juveniles, but long range movement data does suggest that the lighted, manned platforms are an attractant for individuals. In addition, the site fidelity and home range data suggests that blue runner maintain a medium- to long-term presence at the platforms and the increased food availability and predator refugia could lead to an increase in production.

5.6 Fish as CTDs

The use of a CTD to measure the environmental parameters of the water column can be augmented through the use of the temperature and pressure sensors in the acoustic tags. During the 2005 study period a YSI Sonde cast was performed three times a day (morning, noon and evening). The data can be used to show the presence of a thermocline in the water column throughout the study period (Fig. 5.9A). Another way to measure the temperature in the water column without having to use a CTD is to use the temperature sensors in the acoustic tag. The temperature data from the tag in Fish 33800 can be seen in Figure 5.9B. When compared to the YSI-sonde pattern, the data from the fish tag are very similar. The blue runner did not provide as long a temporal data set as the daily CTD cast, but the tag did provide a measurement of a slightly deeper portion of the water column. One may not want to completely rely on the data from the tags, but it can provide a good accessory data set to the CTD casts or offer a means of monitoring the temperature when observers are not present to conduct CTD casts.

5.7 Further Research Needed

The temperature data derived from the surgically implanted tags can be utilized to help investigate the bioenergetics of the blue runner by combining the data with the estimated swimming velocity data. These data points could theoretically be combined to estimate the energetic requirements of the blue runner throughout the day. Keenan et al (2003) showed that blue runner have different food items in their guts during the day than at night. The bioenergetic data can be compared to the feeding studies to determine the energy subsidy provided by the different food sources.

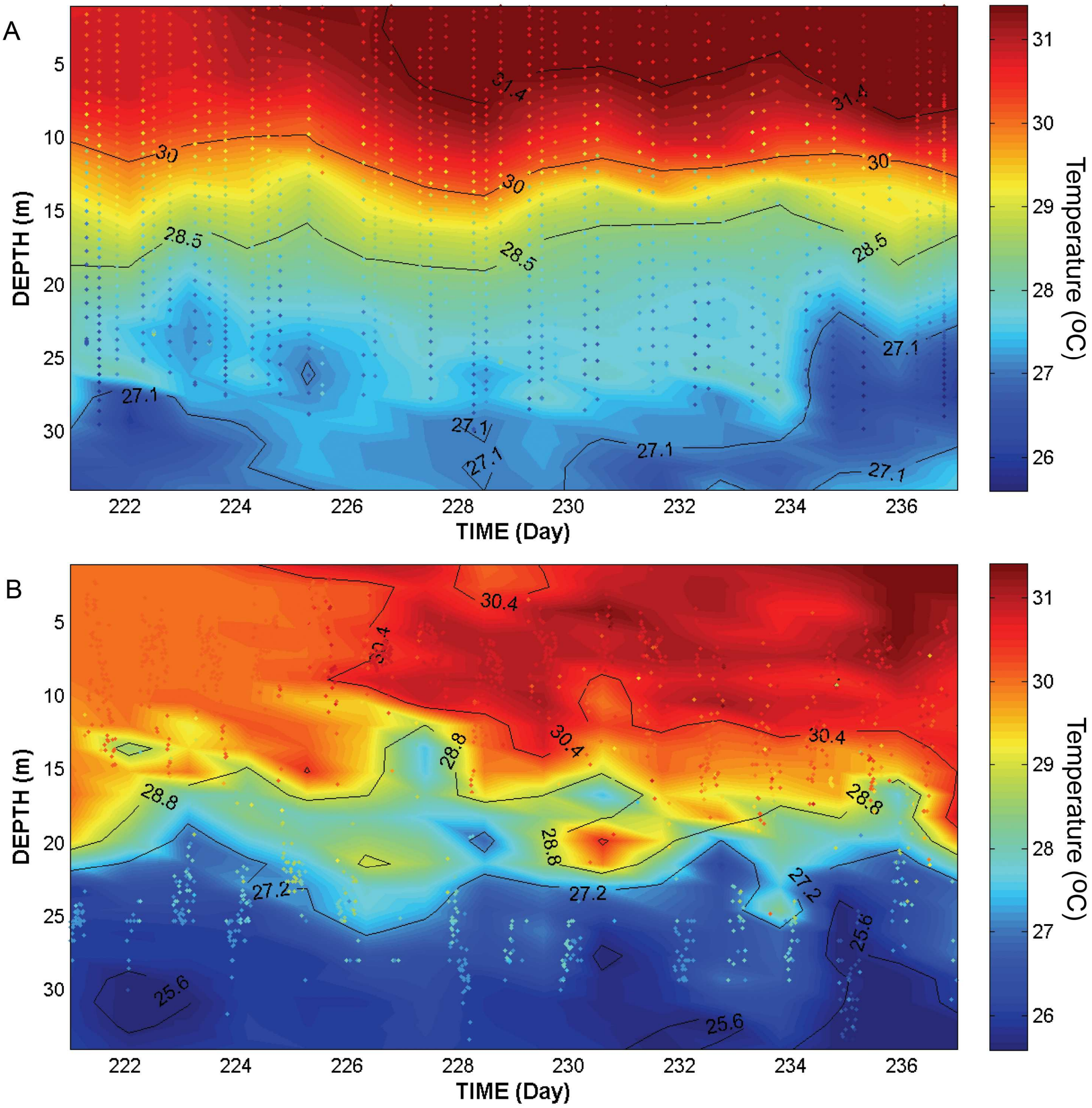

Figure 5.9. 5.9A shows the interpolated temperature data from daily CTD casts during the 2005 study period. 5.9B shows the interpolated temperature data from Fish 33800 tag data during the 2005 study period.

The data presented here is derived from a small proportion of the population of blue runner present at the ST151 complex. To confirm these findings an expansion of the number of tagged fish would be necessary. In addition, the research was focused on only one species of pelagic fish. The petroleum platforms in the Gulf of Mexico are home to a number of species important to the fishing industry. By expanding the scope of this research to include concurrent telemetry studies of other species, such as amberjack, cobia and mackerel, which are predators of blue runner, valuable insights into the spatial and temporal dynamics of predator prey interactions could be revealed.

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APPENDIX A: ACOUSTIC CHARACTERIZATION OF THE ST151 MAINE COMPLEX AND TRANSMITTER RANGE TESTING

On August 5 – 6, 2004 the acoustic characterization of the underwater platform environment was assessed by representatives of Lotek Wireless. This testing was done in order to identify any issues, which may affect the performance of the hydrophone system. Over the two-day period eleven samples were collected using a 500 kHz transmitter with a ten-second ping rate (Table A.1).

Tests were conducted on the plus 10 deck of the Y platform of ST-151. All measurements were conducted under the following conditions:

ADC Board	National Instruments DAQ card 6062E; SHC68-68-EP; SCB-68		
Software Tools	Matlab v. 7.0 ; NI DAQ; Custom Scripts		
Hydrophone	Reson TC4014 (S.N. 420214)		
Depth	z = - 6mLocation	SE corner of Y platform	
Transmitter ID	49100		
Repetition Rate	5 seconds		
Depth	z = -3m		
Location	SW section of Y platform		

Table A.1. Summary of the testing for acoustic characterization of the ST151 main complex.

File Name	***Date***	***Time***	***Conditions***
MS0501	Aug 5, 2004	1258	Tag in air
MS0502	Aug 5, 2004	1300	No tag; 0.5 m swell
MS0503	Aug 5, 2004	1305	Tag –3 m; 0.5 m swell
MS0504	Aug 5, 2004	1308	Tag –3 m; 0.5 m swell
MS0505	Aug 5, 2004	1522	No tag; 0.5 m swell
MS0506	Aug 5, 2004	1525	No tag; 0.5 m swell
MS0507	Aug 5, 2004	2036	No tag; 0.5 m swell
MS0508	Aug 5, 2004	2038	No tag; 0.5 m swell
MS0601	Aug 6, 2004	1001	No tag; 1 m swell
MS0602	Aug 6, 2004	1003	No tag; 1 m swell
MS0603	Aug 6, 2004	1005	No tag; 1 m swell

The data files were taken back to Lotek Wireless's offices in Newmarket, Ontario, Canada to examine the data for evidence of environmental noise. Analysis of the data revealed no conflicting acoustic signals in the 75 kHz band. The data showed higher noise levels at night than during the day, but the source of the difference was not determined, as the testing was not designed for such a purpose.

In addition range testing was performed to determine expected detection range for the transmitters and receivers. A MAP receiver was temporarily installed on the plus 10 deck of ST151 Yankee. A hydrophone was suspended at approximately 6m depth below the platform. To ensure line of sight testing with the tag, the hydrophone was suspended from either the SE or SW corner of the platform. A tag was attached to a monofilament line and lowered from the surface to the bottom and then slowly brought up through the water column. Tag detections were monitored in real time using a laptop computer running MAPHOST. Data was also stored on a data card in the MAP receiver for archiving. Detections were consistent throughout the tag deployments, except for the deployment from ST151 Oscar, which showed better detection closer to the surface (Table A.2), though the agitated sea state may have played a role in the depth dependence.

Table A.2. Summary of the results of tag range testing at the ST151 main complex and ST 151 Oscar.

Test	***Date***	***Tag Location***	***Hydrophone Location***	***Result***
1	Aug 5, 2004	NW corner Prod 1	E edge of Y	Consistent
2	Aug 5, 2004	Midway between OQ & Prod 1	E edge of Y	Consistent
3	Aug 5, 2004	Midway between OC & Prod 2	E edge of Y	Consistent
4	Aug 5, 2004	NW corner Prod 2	E edge of Y	Consistent
5	Aug 5, 2004	S corner G deck	E edge of Y	Consistent
6	Aug 5, 2004	NW corner Comp	E edge of Y	Consistent
7	Aug 6, 2004	SE corner of Oscar	W edge of Y	Depth Dependant

APPENDIX B: ANESTHESIA EXPERIMENTS

Mark Benfield and Harmon Brown, 23Jul05

All fish caught using hook and line

Bar Jack placed in a 25 ppm MS-222 solution (o.5g MS-222 in 20L of seawater)
Fish did not become anesthetized.
Concentration increased to 50 ppm (1.0 g MS-222 in 20L of seawater)
Fish eventually became anesthetized.
Placed in a 5 gal bucket of seawater to recuperate.
Returned to ocean after about 1 minute of recuperation.
No visible side effects seen.

Second Bar Jack placed in 75 ppm MS-222 solution (1.5g MS-222 in 20L of seawater)

Became anesthetized in about 10 seconds.
Placed in a 5 gal bucket of seawater to recuperate.
Returned to ocean after about 3 minutes of recuperation.
No visible side effects seen.

Blue runner (~28 cm SL) placed in 75 ppm MS-222 solution (1.5g MS-222 in 20L of seawater)

Fish did not become anesthetized.
Concentration increased to 100 ppm (2.0 g MS-222 in 20L of seawater)
Fish became anesthetized in about 1 minute.
Placed in a 5 gal bucket of seawater to recuperate.
Returned to ocean after about 5 minutes of recuperation.
No visible side effects seen.

Blue runner (24 cm SL) placed in 80 ppm MS-222 solution (2.0 g MS-222 in 24L of seawater)

Fish became anesthetized in about 3 minutes.
Placed in a 5 gal bucket of seawater to recuperate.
Returned to ocean after about 5 minutes of recuperation.
No visible side effects seen.

APPENDIX C: BLUE RUNNER SURGERY PROTOCOL

1. Fish were caught using barbless hooks and lures.
2. Fish were allowed to equilibrate in a tank with aerated sea water.
3. Fish were placed in an 80ppm solution of Tricaine Methane Sulphonate (MS-222) and seawater until completely anesthetized.
4. Fish were weighed to the nearest gram and measured (standard lenth) to the nearest millimeter.
5. Fish were placed on the surgical table ventral side up and a 50ppm solution of MS-222 and seawater is pumped over their gills through a plastic tube placed in the mouth*.
6. The area between and around the pelvic fins and the anus was swabbed with betadine.
7. Scales were removed between the pelvic fins and the anus using forceps† to facilitate the following incision.
8. A small incision was made posterior to the pelvic fins using a scalpel.
9. The incision was lengthened from the pelvic fins to anterior of the anus using surgical scissors.
10. An acoustic tag was inserted anteriorly in the peritoneal cavity of the fish.
11. The incision was sutured using PDS sutures.
12. Antibiotic ointment was applied to the sutured incision area.
13. 1cc of Oxytetracycline was delivered subcutaneously to the fish through a syringe.
14. Fish was placed in an aerated seawater tank until it revived from the anesthetic (approximately 10 – 15 minutes).
15. Fish was moved to a holding pen for at least 8 hours before being released.

* Condition of the fish was constantly monitored. If the fish appeared to be prematurely recovering from the anesthesia, then an 80ppm MS-222 and seawater solution was pumped over the gills using a large syringe. If the fish did not exhibit gilling or finning behavior, then aerated seawater was pumped over the gills using a large syringe.

† All surgical instruments and acoustic tags were sanitized using Activated Cidex and rinsed in sterile saline solution prior to use. Sutures were not soaked in Cidex (per manufacturer's instructions).

APPENDIX D: SUMMARY OF FISH SWIMMING SPEED ANALYSIS

Table D.1. Summary of the swimming speeds of different species of fish.

Species	***Body Lengths/s***	***Standard Error***	***cm/s***	***Standard Error***
Onchorhynchus kisutch	8	2	359	72
Onchorhynchus mykiss	3.5	0.5	206	20
Carassius auratus	10.2	0.8	137	63
Gadus merlangus	7	2	125	55
Juvenile pompano	9.3	0.17	95.9	1.13
Juvenile pompano	9.45	0.44	91.41	4.86
Clupea harengus	8	2	99	32
Scomber scombrus	7	2	245	55
Pomalobus psuedoharengus	15	1	450	50
Trachurus mediterraneus	16.4		258	
Caranx crysos	14.21986	0.248227	401	7
Acanthocybium solandri	18.4		2100	
Thunnus albacares	13.5	7.5	1297.5	774.5
Thunnus thynnus	0.65	0.35	2200	1000

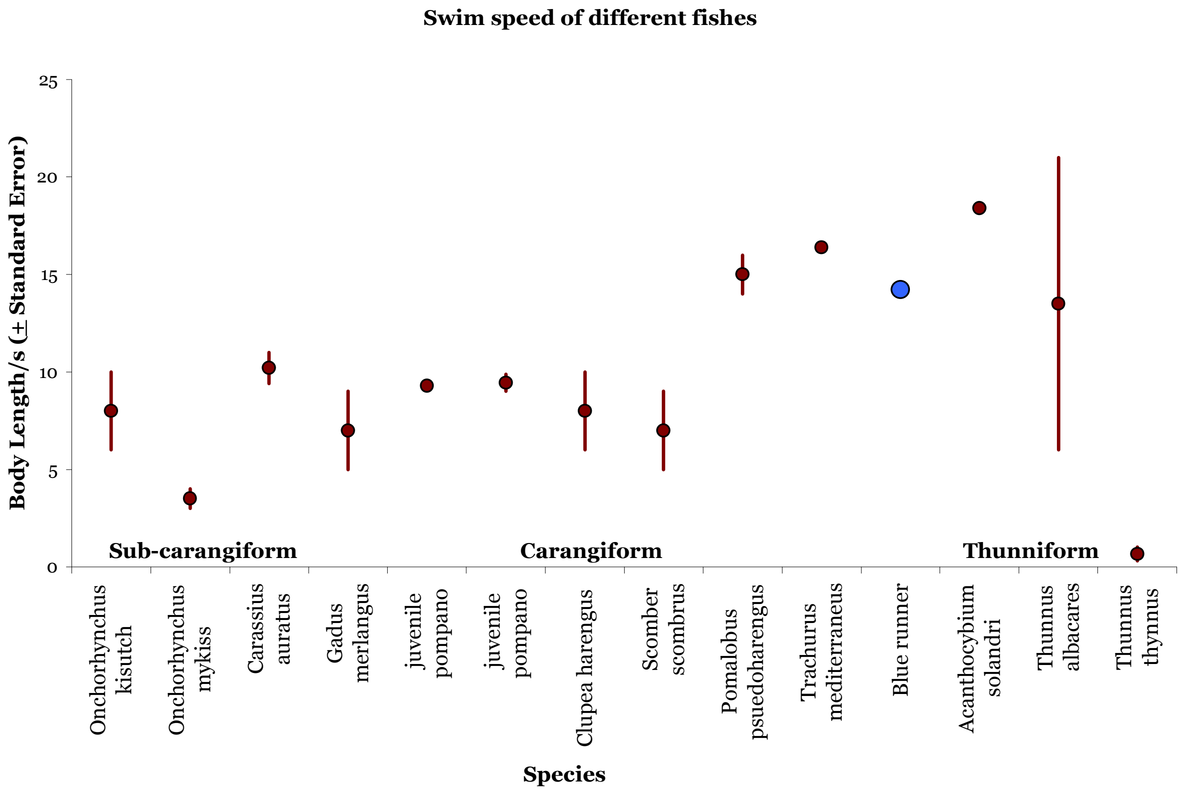


Figure D.1. The swim speeds in body lengths/second of different species of fish.

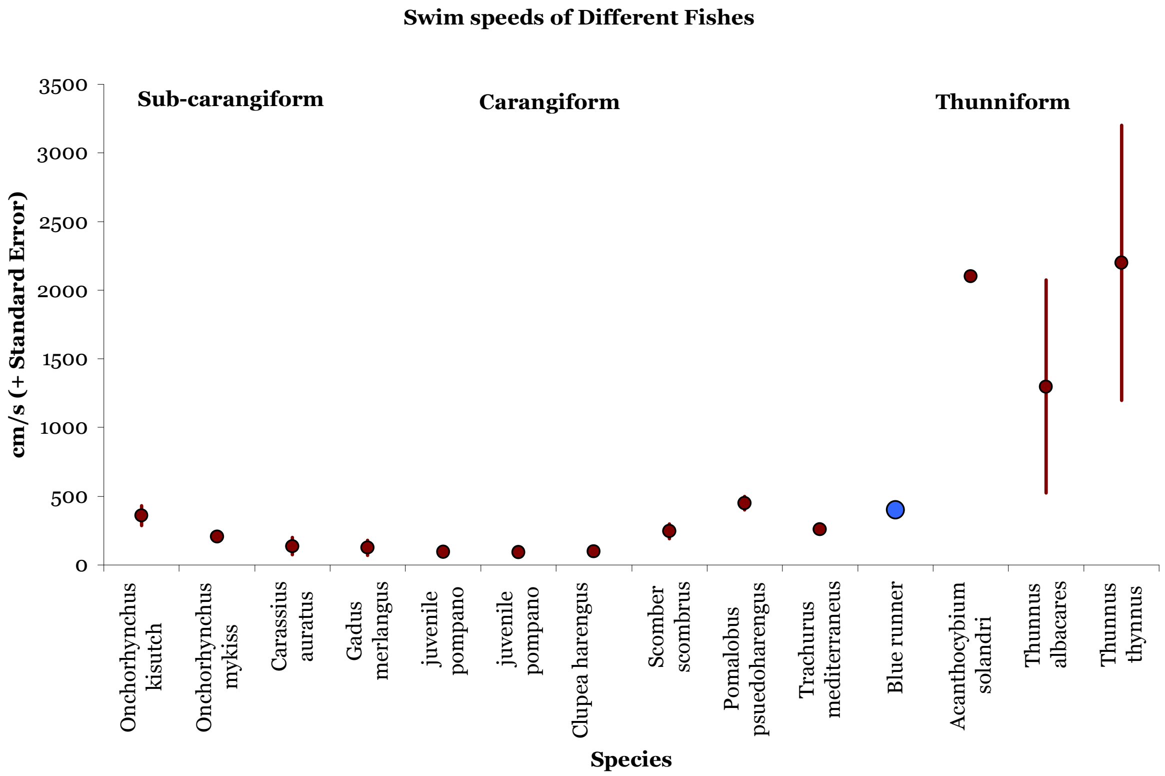


Figure D.2. The swim speeds in cm/second of different species of fish.

APPENDIX E: ADDITIONAL FIGURES FOR CHAPTER 2

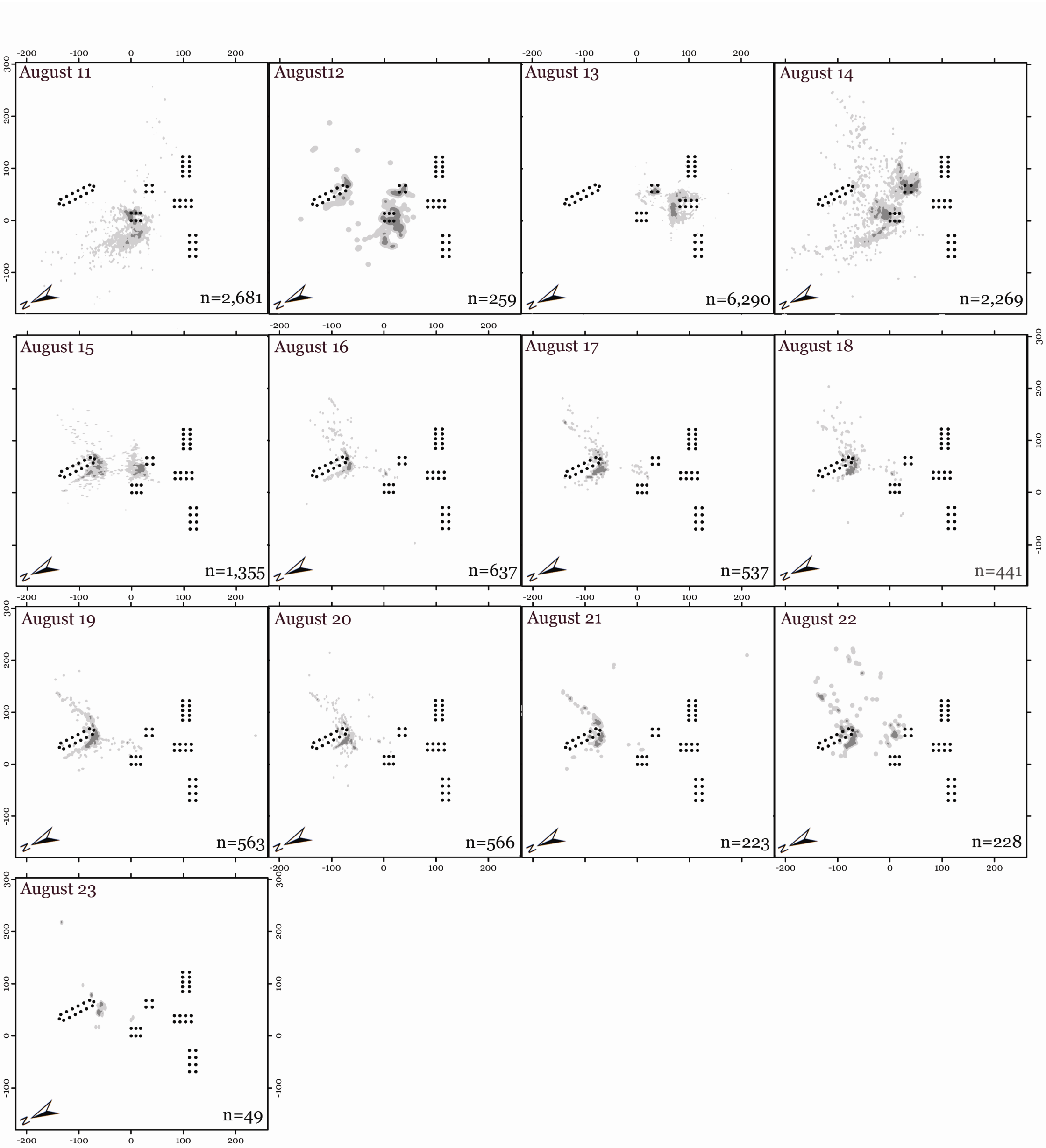


Figure E.1. The home range of tagged Fish 29500 over the period of August 11 - 23, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

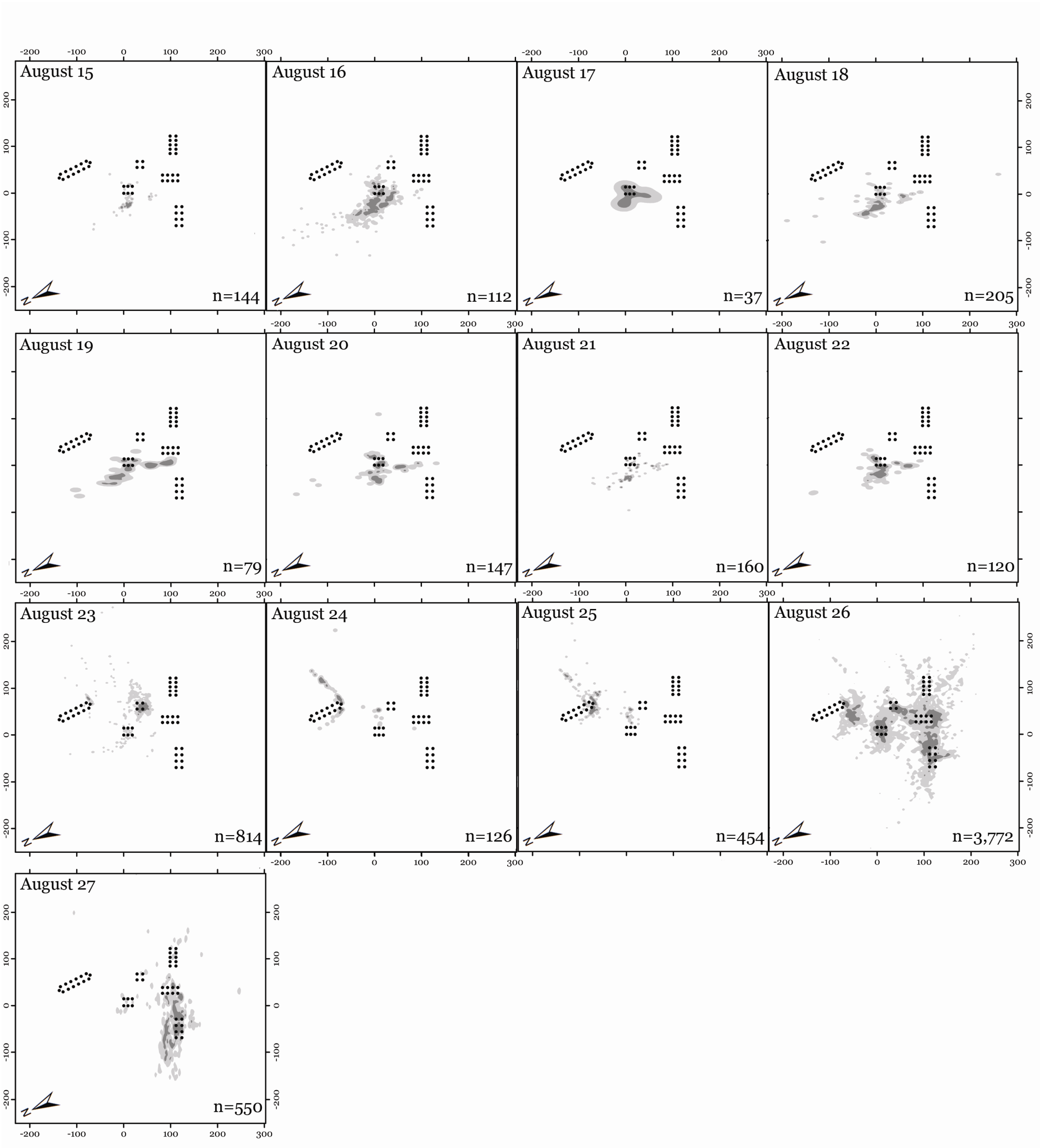


Figure E.2. The home range of tagged Fish 30500 over the period of August 15 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

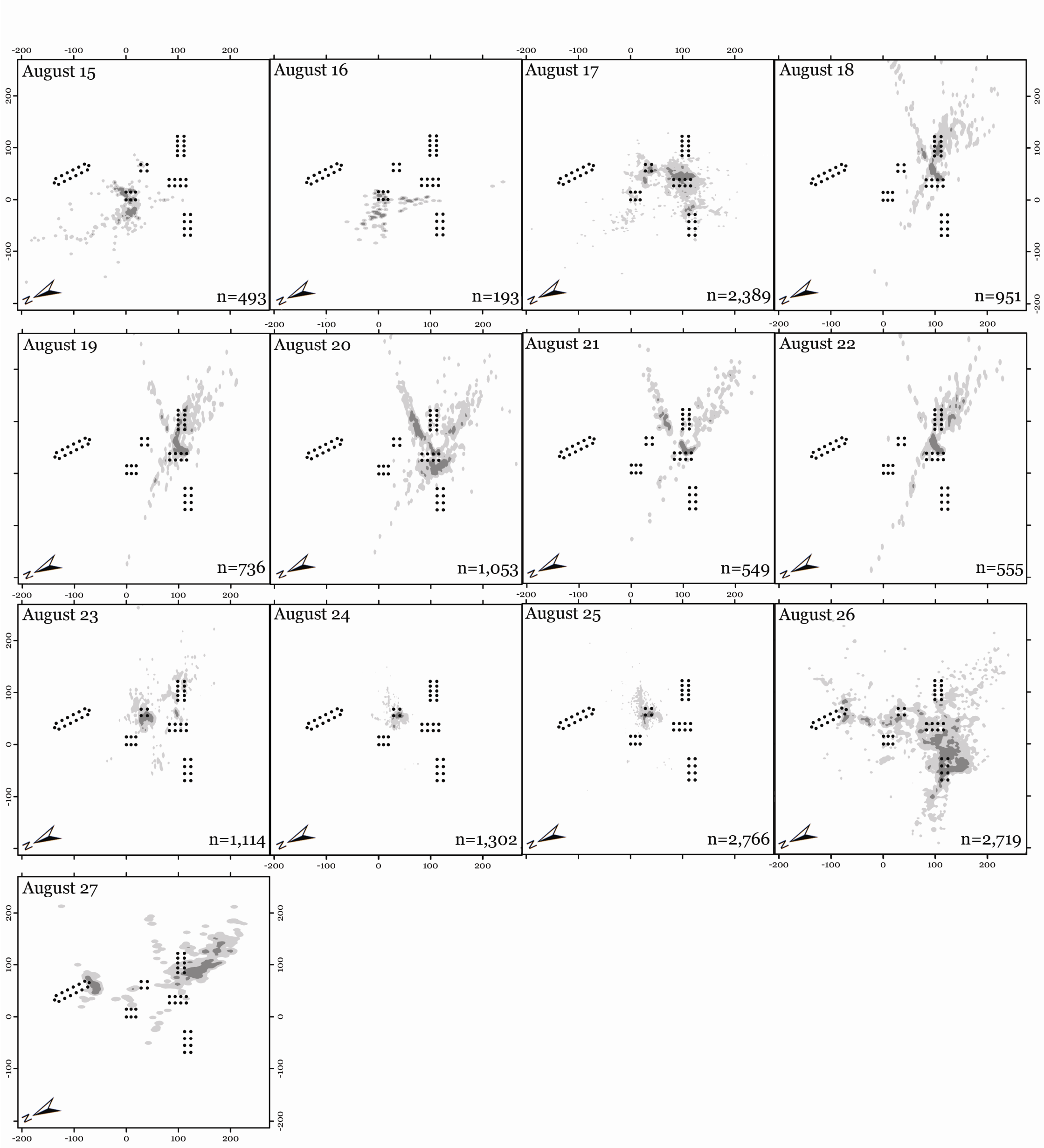


Figure E.3. The home range of tagged Fish 30600 over the period of August 15 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

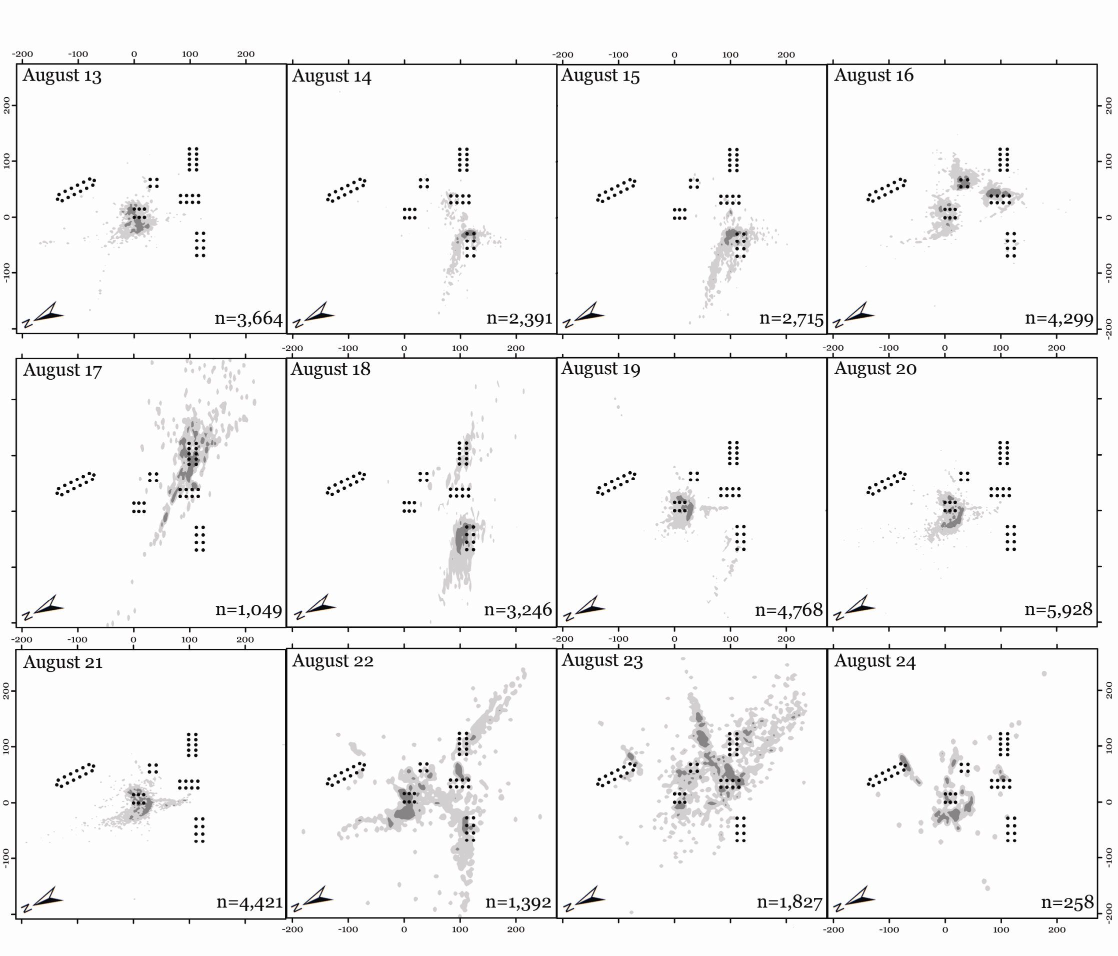


Figure E.4. The home range of tagged Fish 30800 over the period of August 13 - 24, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

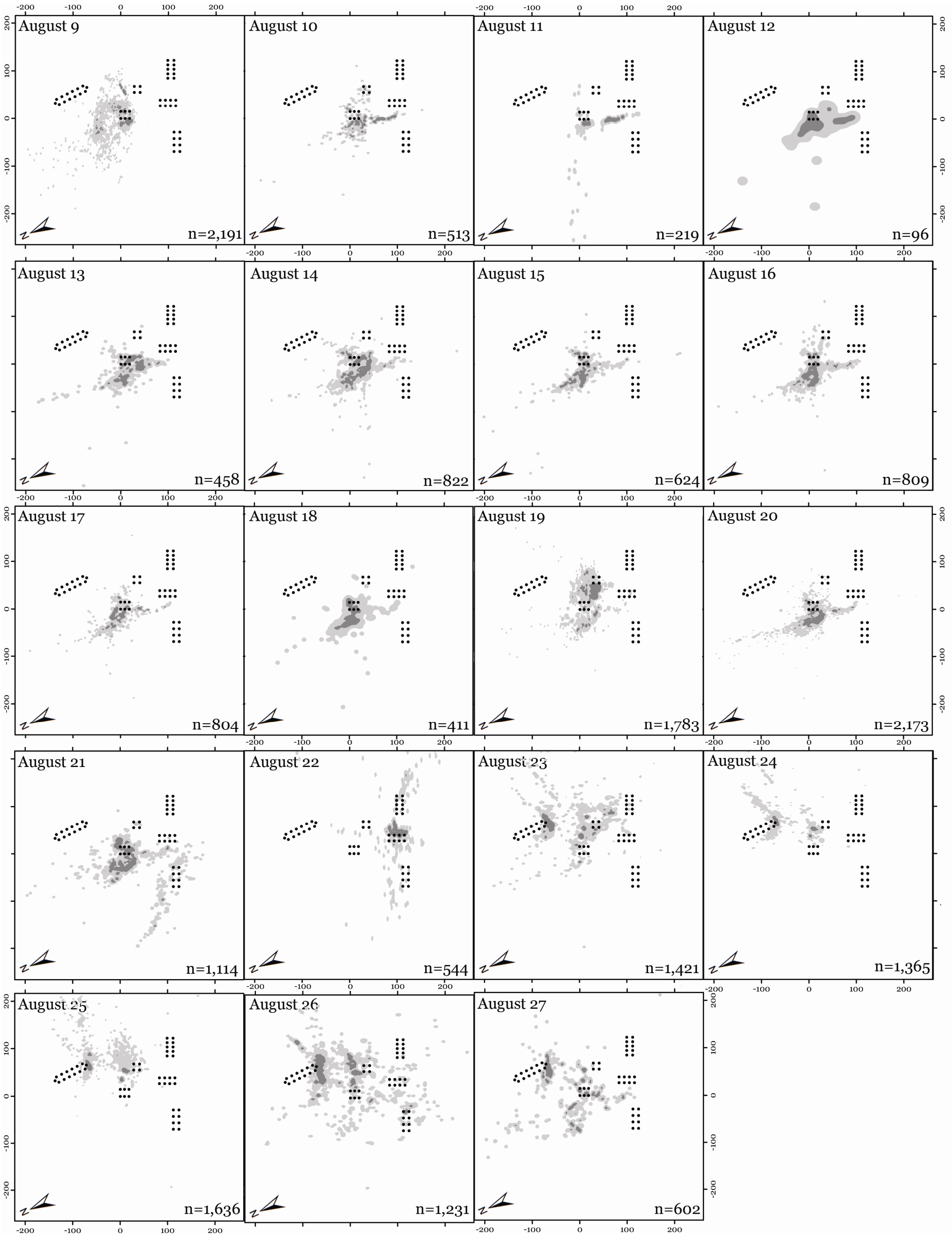


Figure E.5. The home range of tagged Fish 31300 over the period of August 9 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

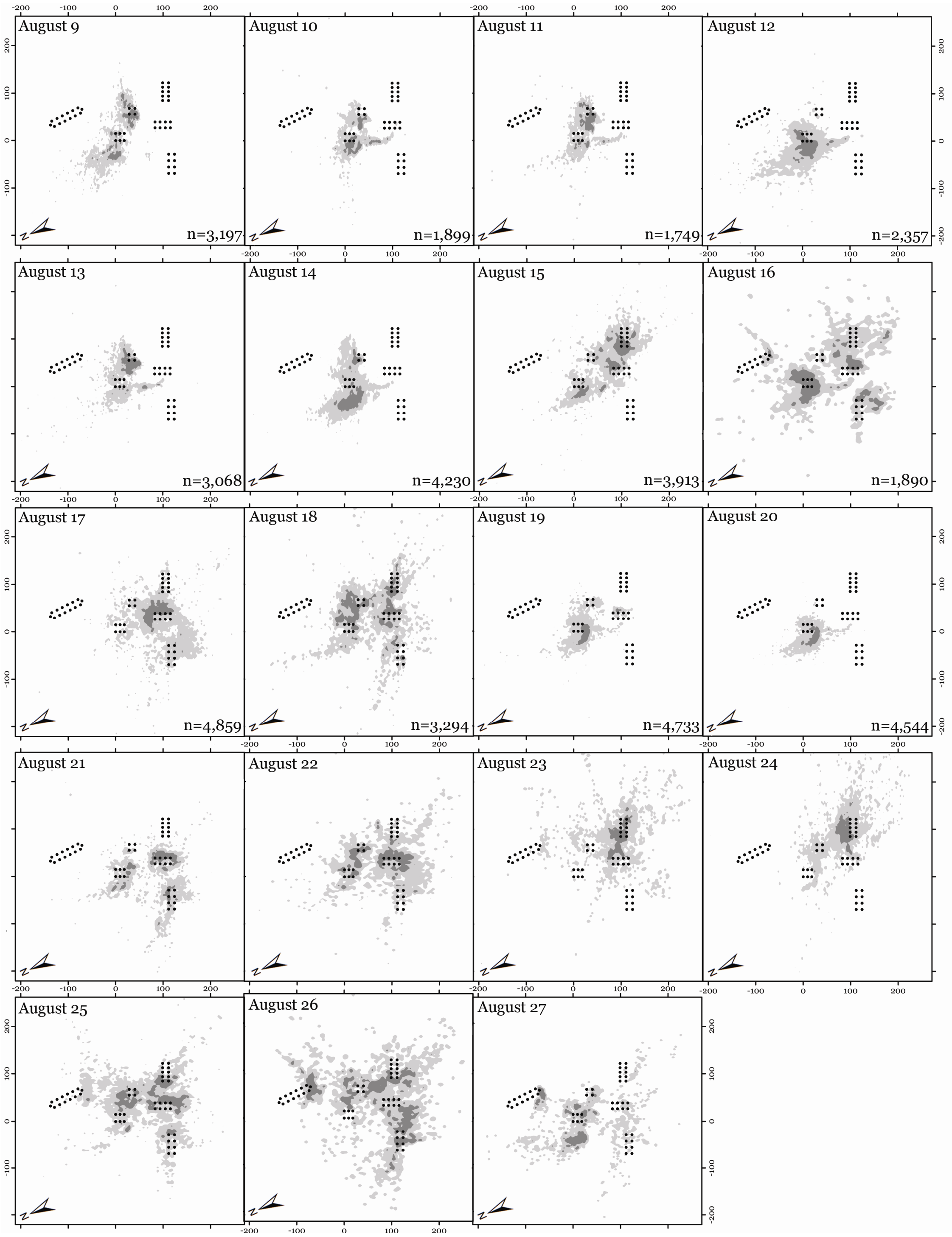


Figure E.6. The home range of tagged Fish 31800 over the period of August 9 -27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

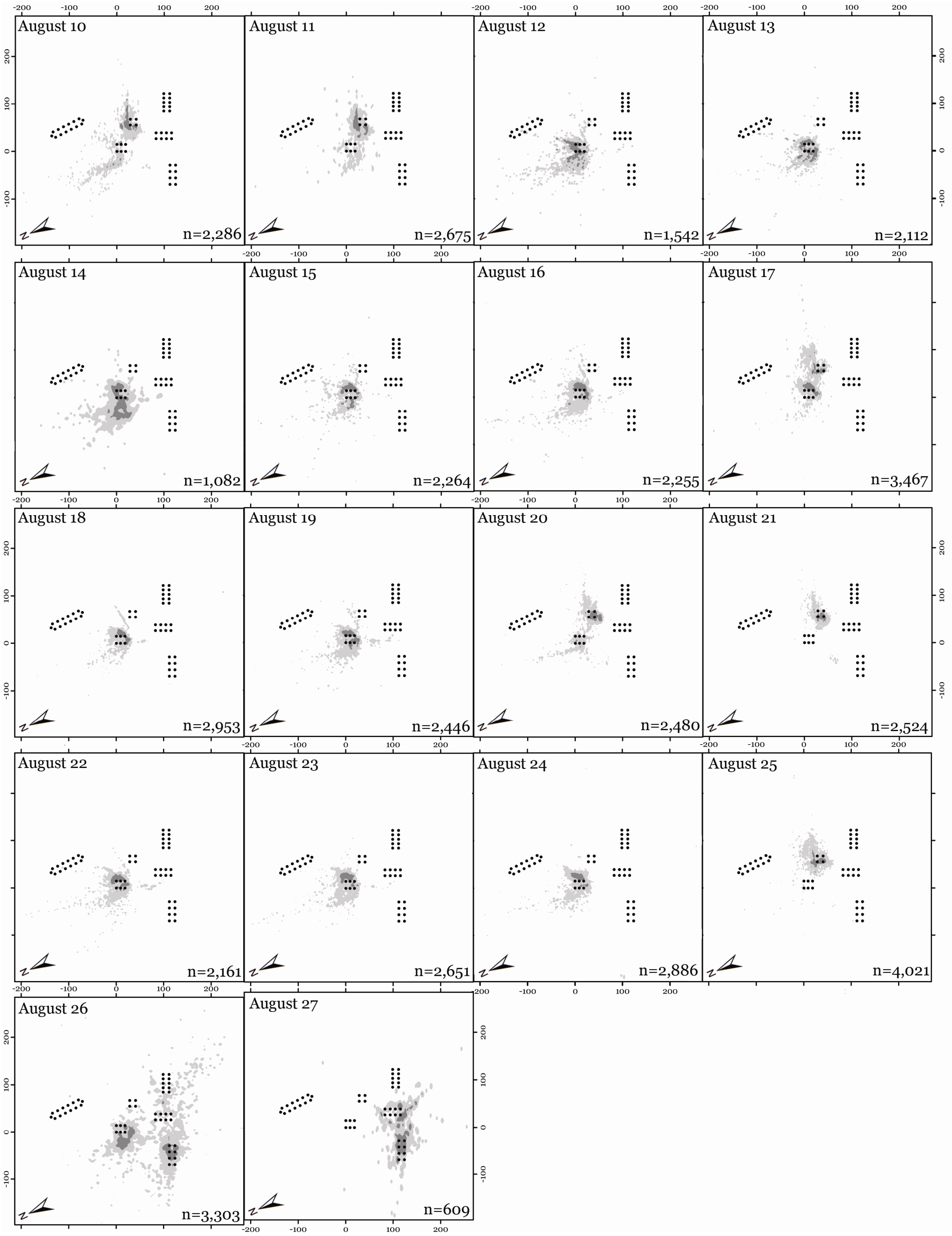


Figure E.7. The home range of tagged Fish 32100 over the period of August 10 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

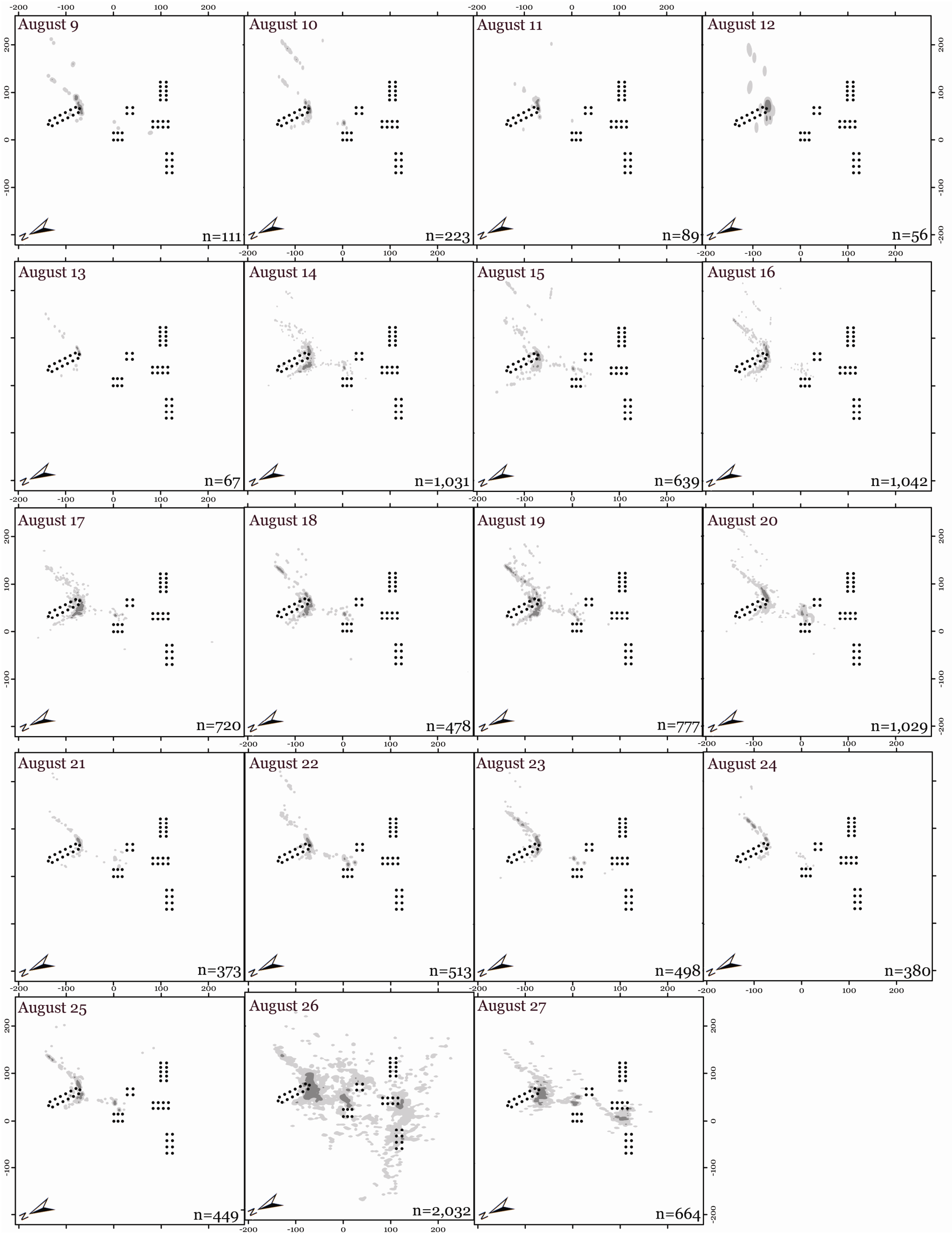


Figure E.8. The home range of tagged Fish 32500 over the period of August 9 – 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

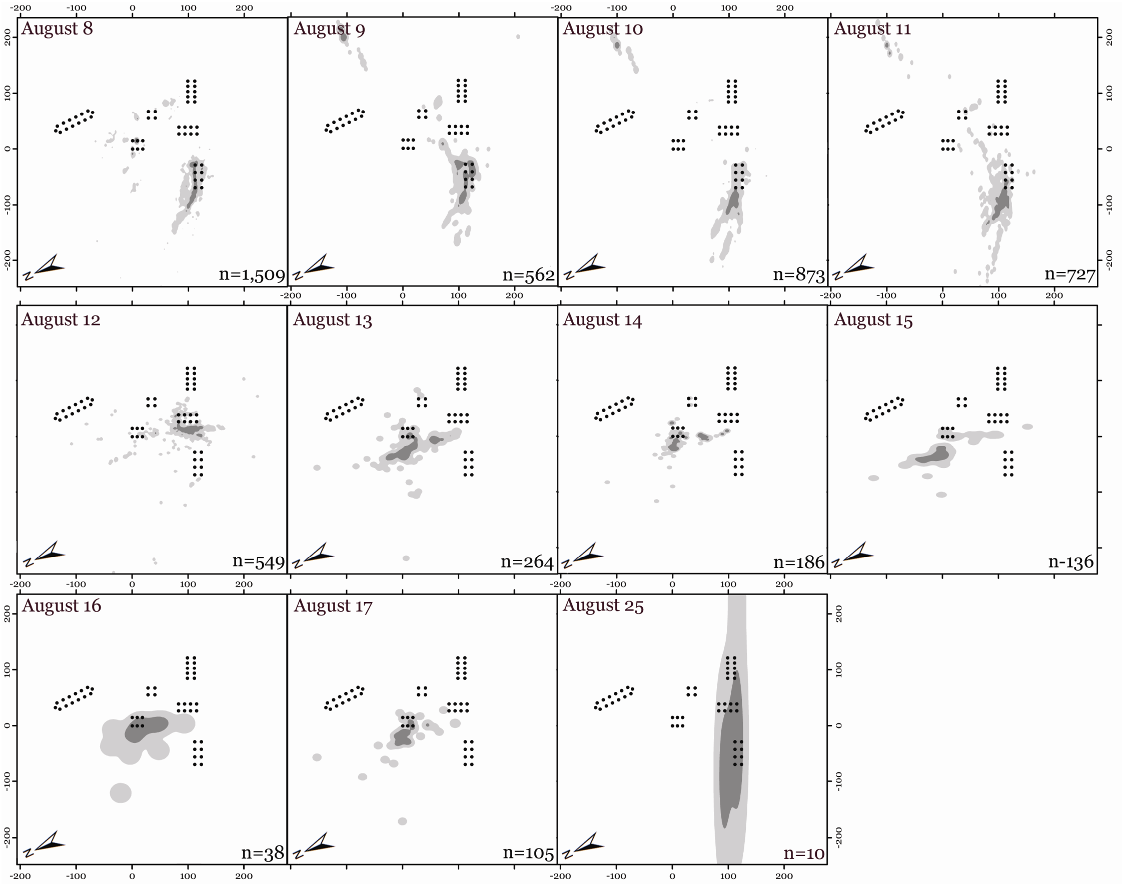


Figure E.9. The home range of tagged Fish 32700 over the period of August 8 - 25, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish. August 18 – 24 are not shown due to lack of localizations during that time period (August 18: n=2; August 19 – 24: n=0).

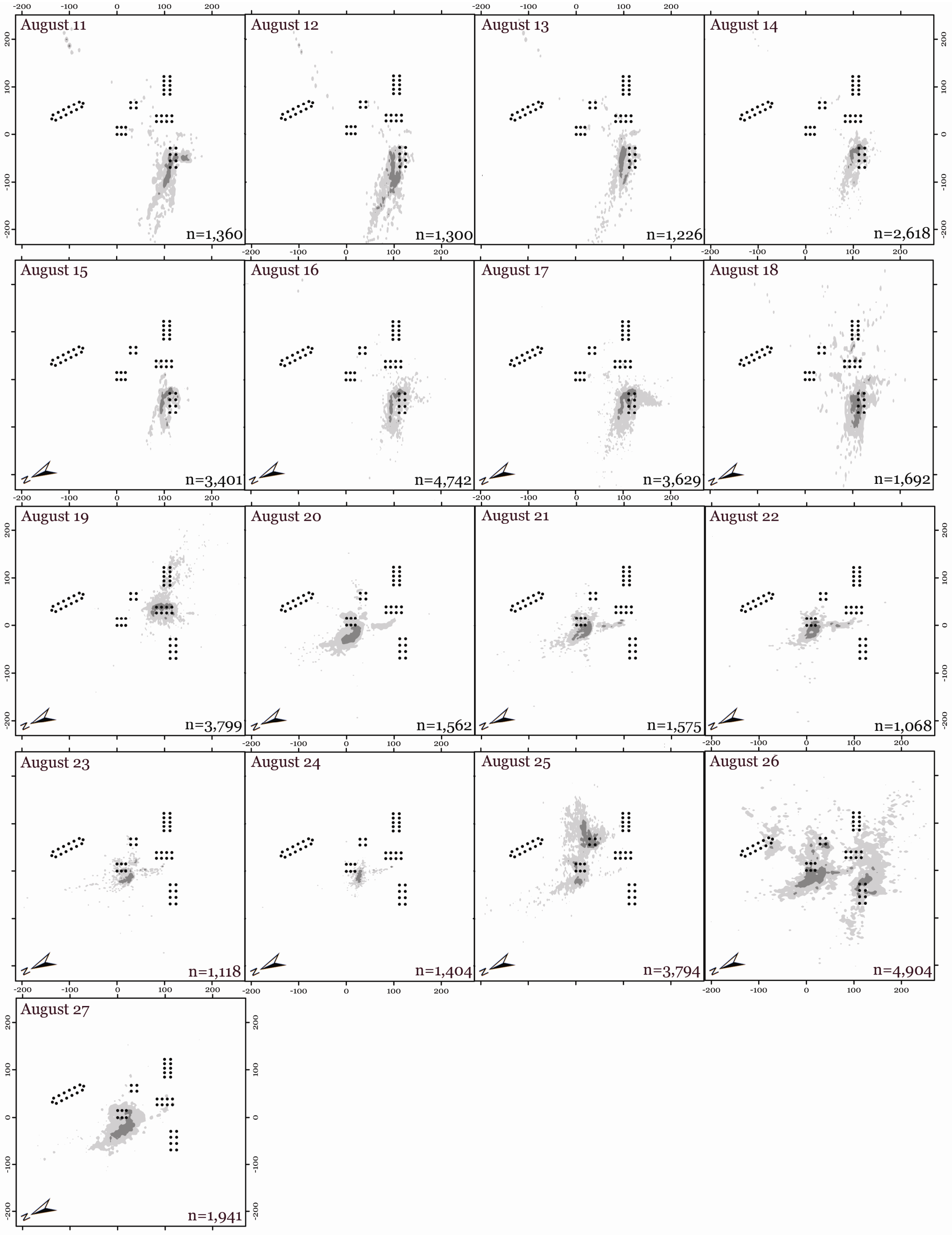


Figure E.10. The home range of tagged Fish 32900 over the period of August 11 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

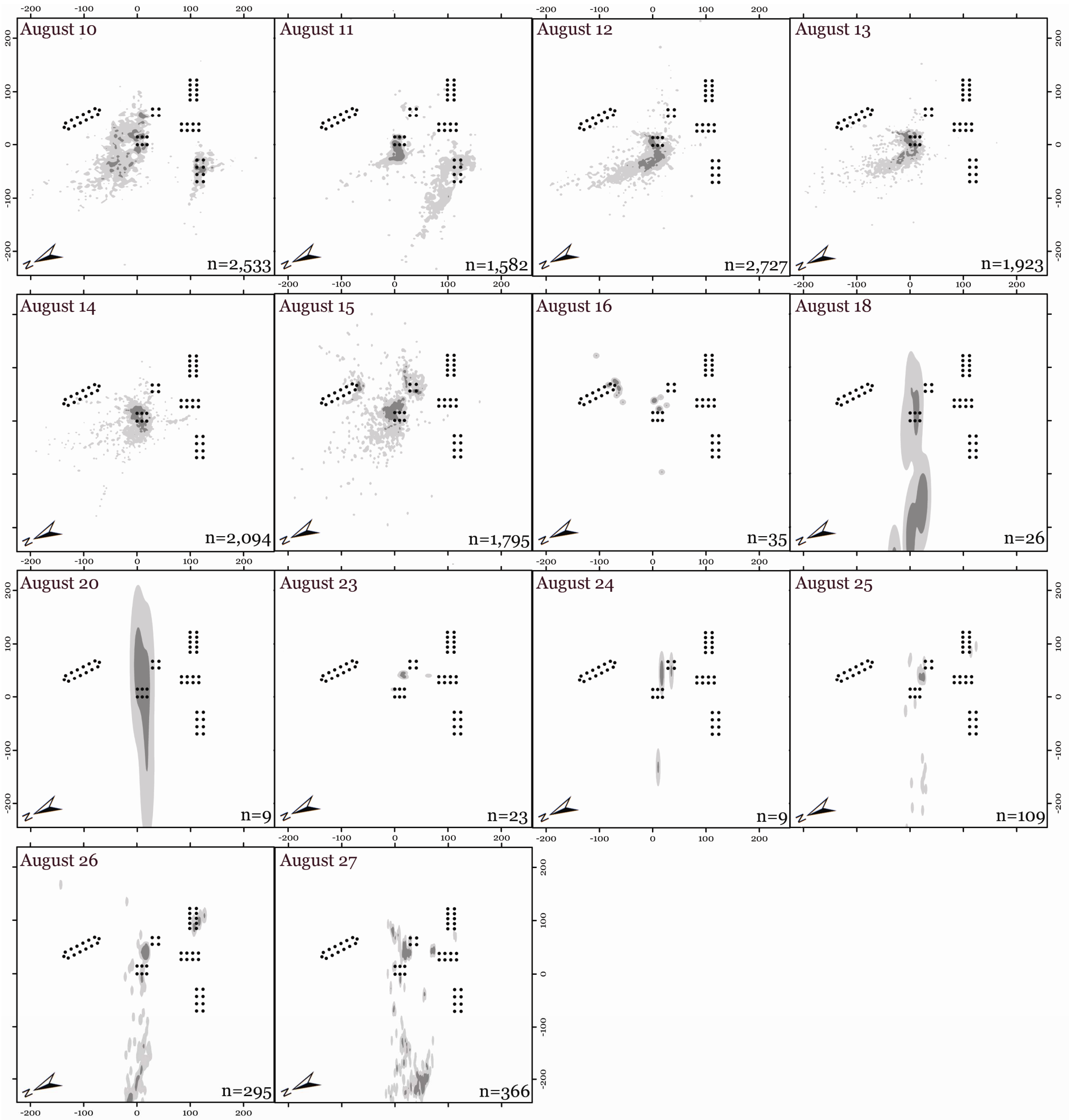


Figure E.11. The home range of tagged Fish 33000 over the period of August 9 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish. August 17 (n=1), August 19 (n=2), August 21 (n=5) and August 22 (n=0) are not shown due to lack of localizations during those time periods.

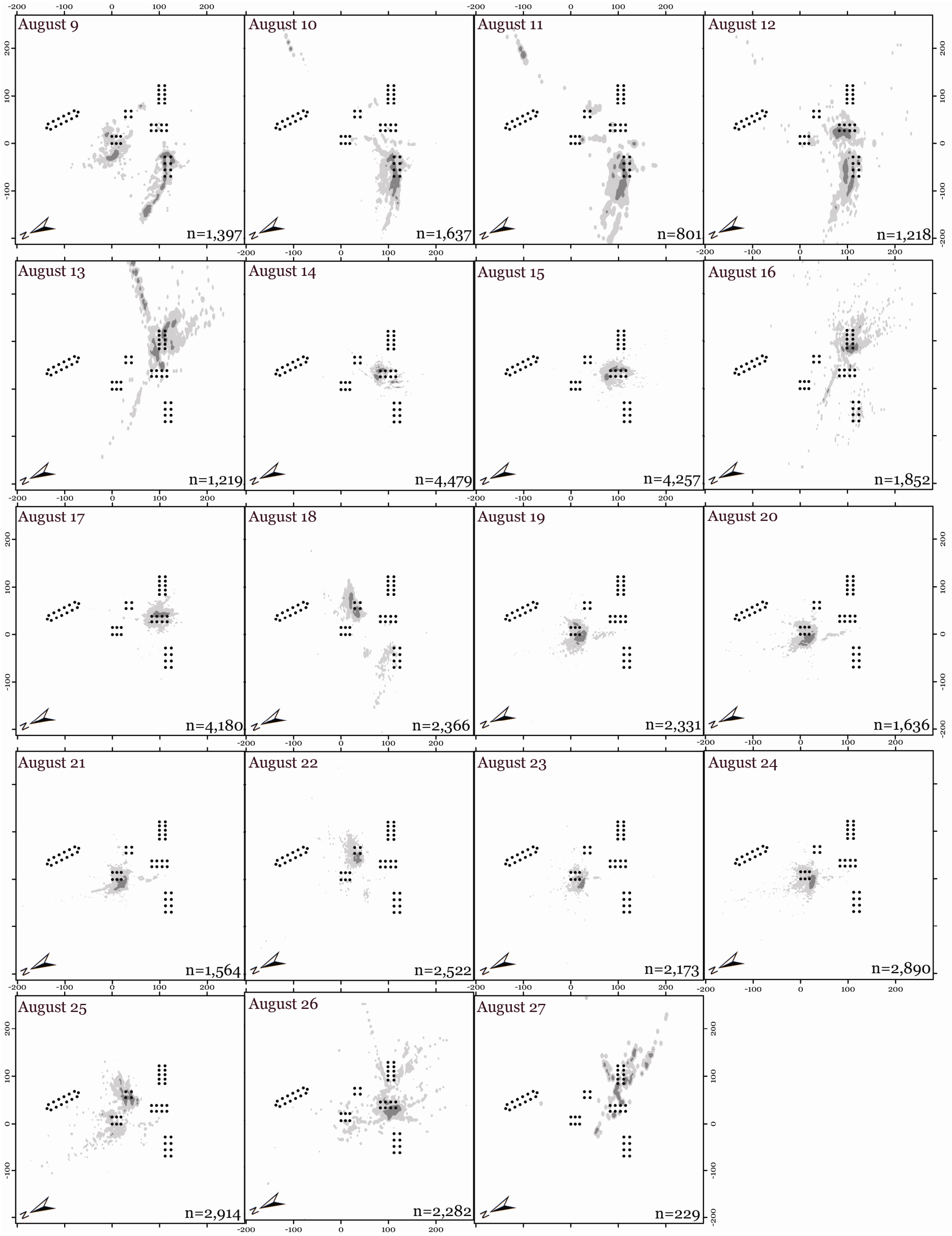


Figure E.12. The home range of tagged Fish 33300 over the period of August 9 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

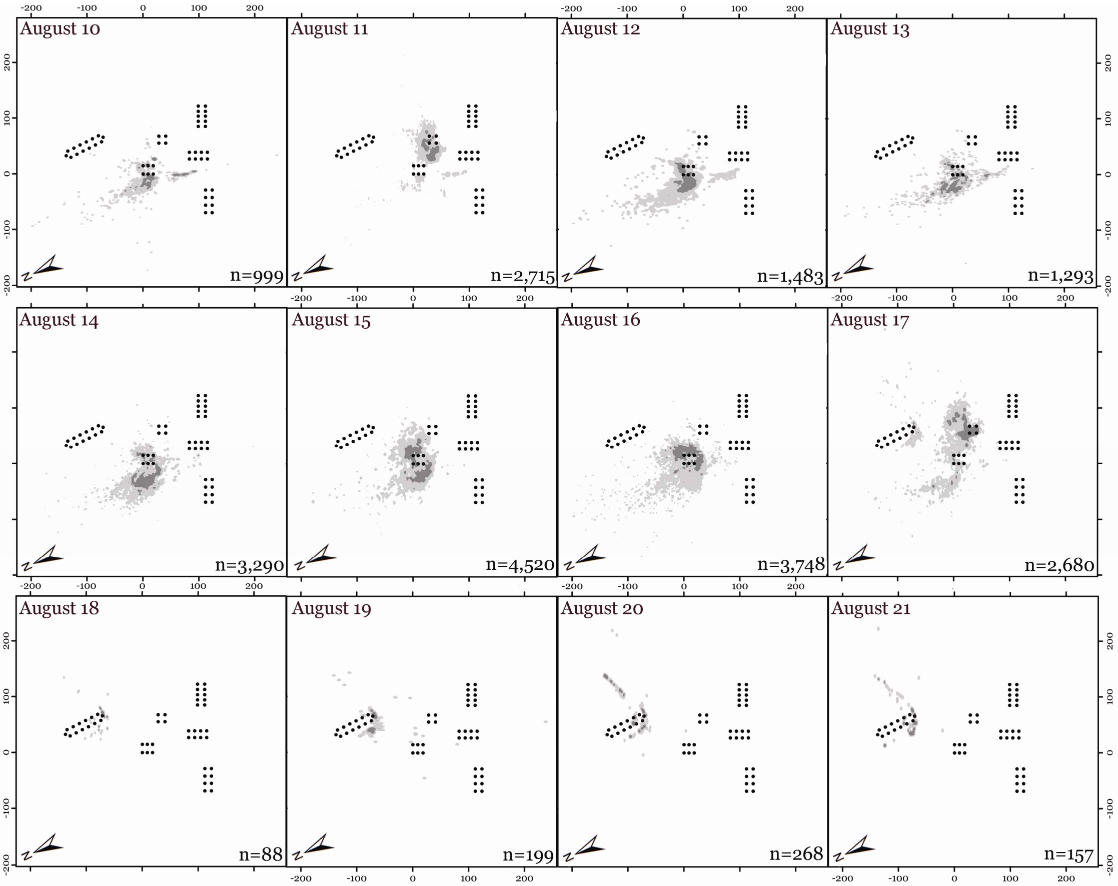


Figure E.13. The home range of tagged Fish 33500 over the period of August 10 - 21, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

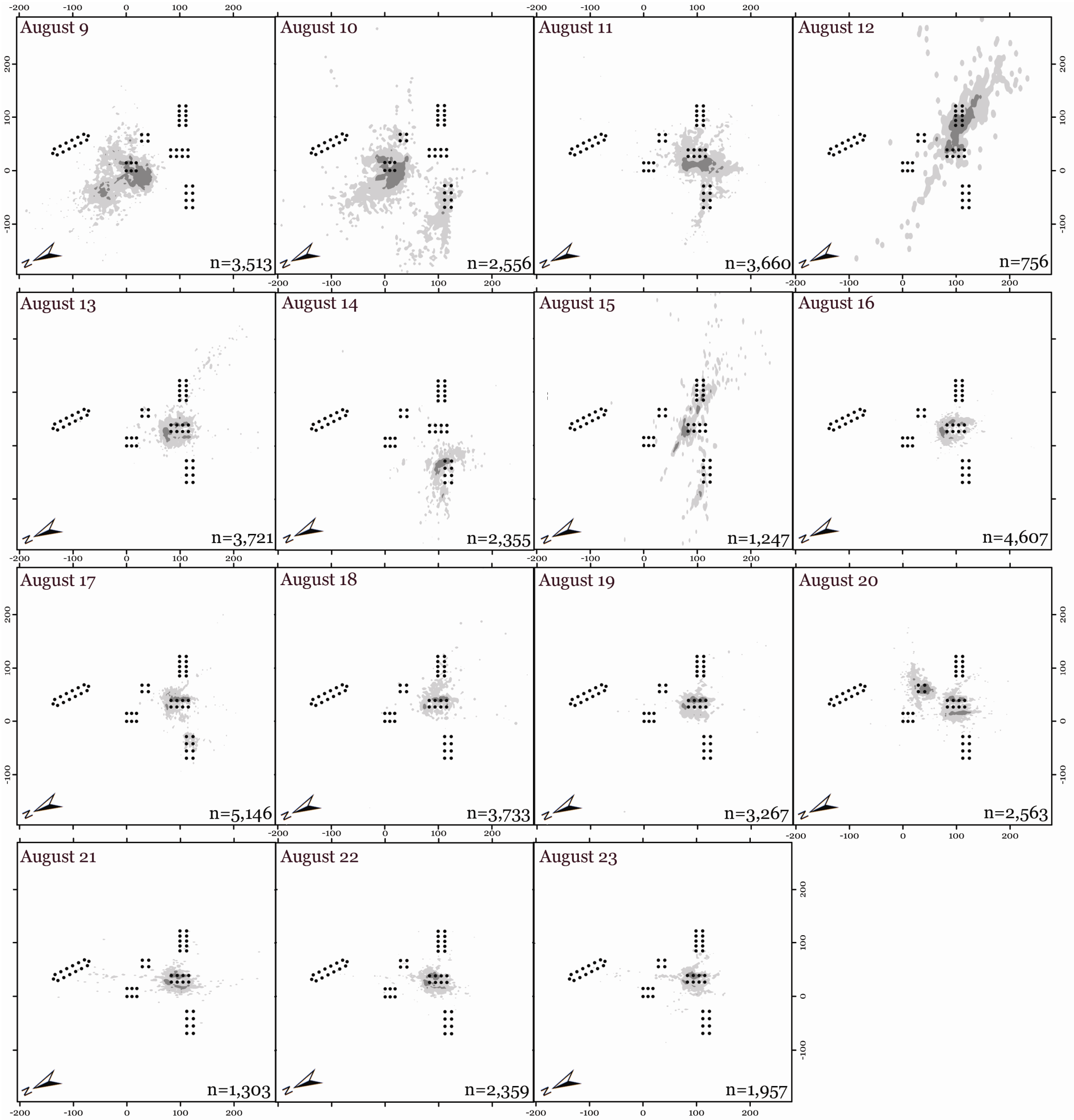


Figure E.14. The home range of tagged Fish 33700 over the period of August 9 - 23, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

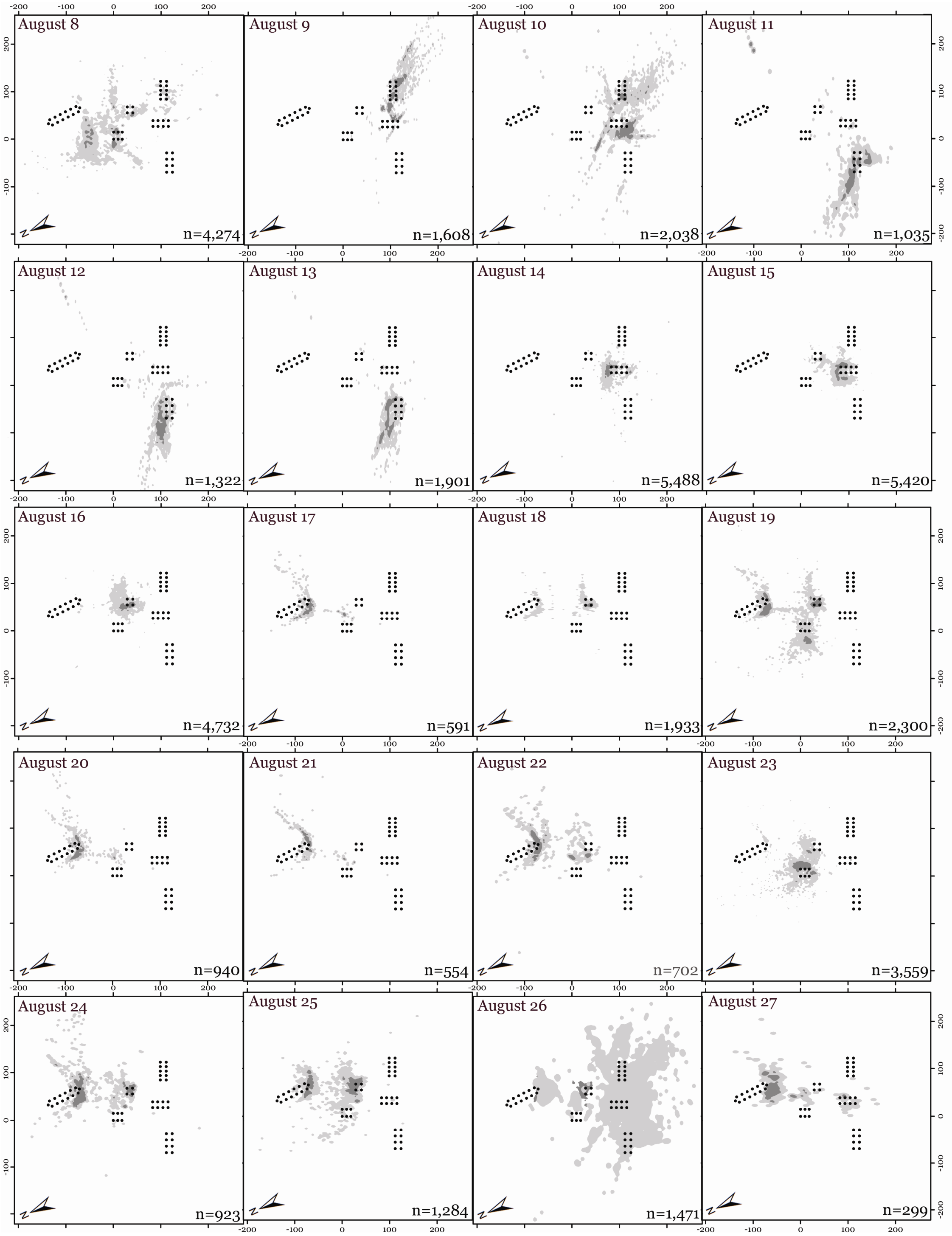


Figure E.15. The home range of tagged Fish 33800 over the period of August 8 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

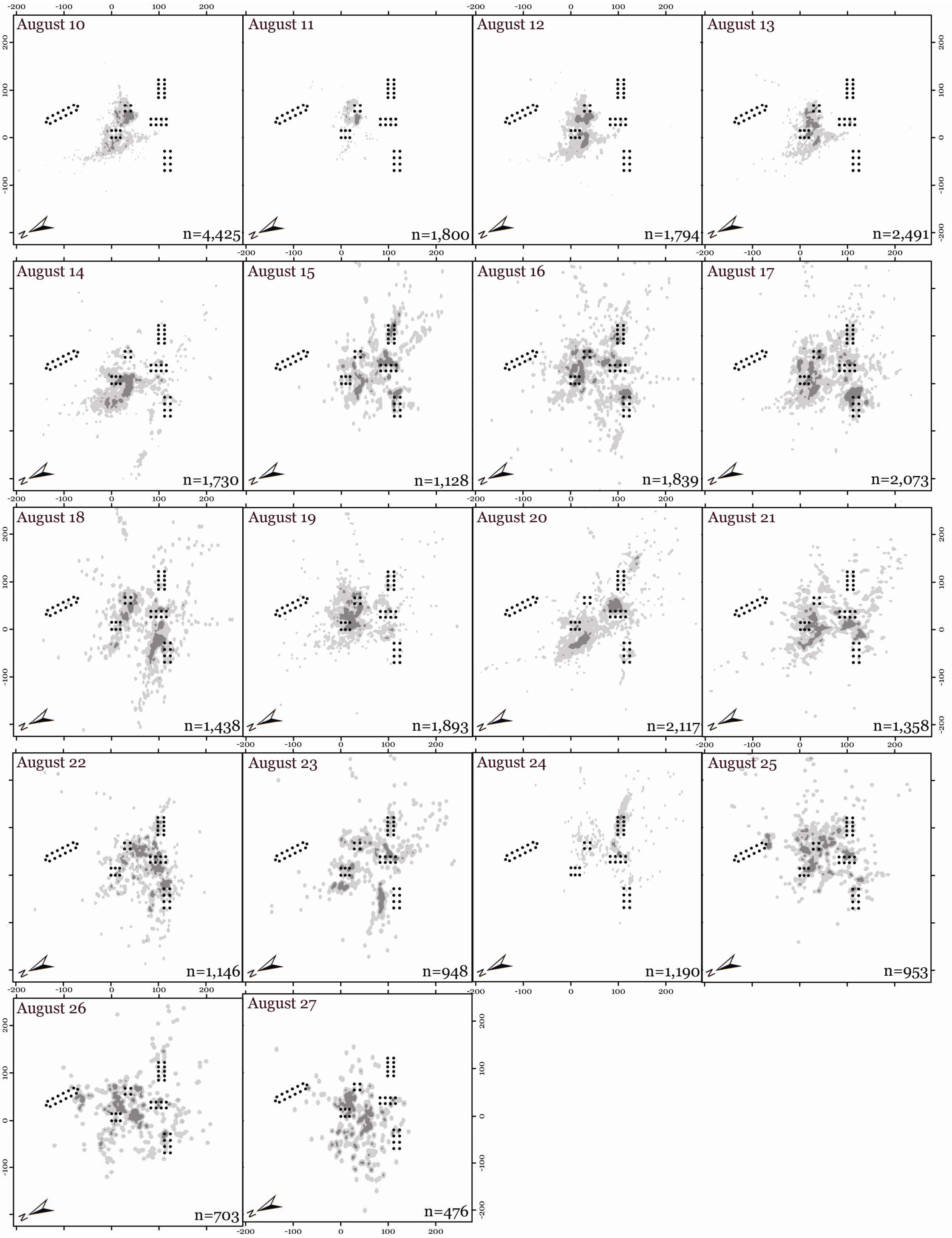


Figure E.16. The home range of tagged Fish 34000 over the period of August 10 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

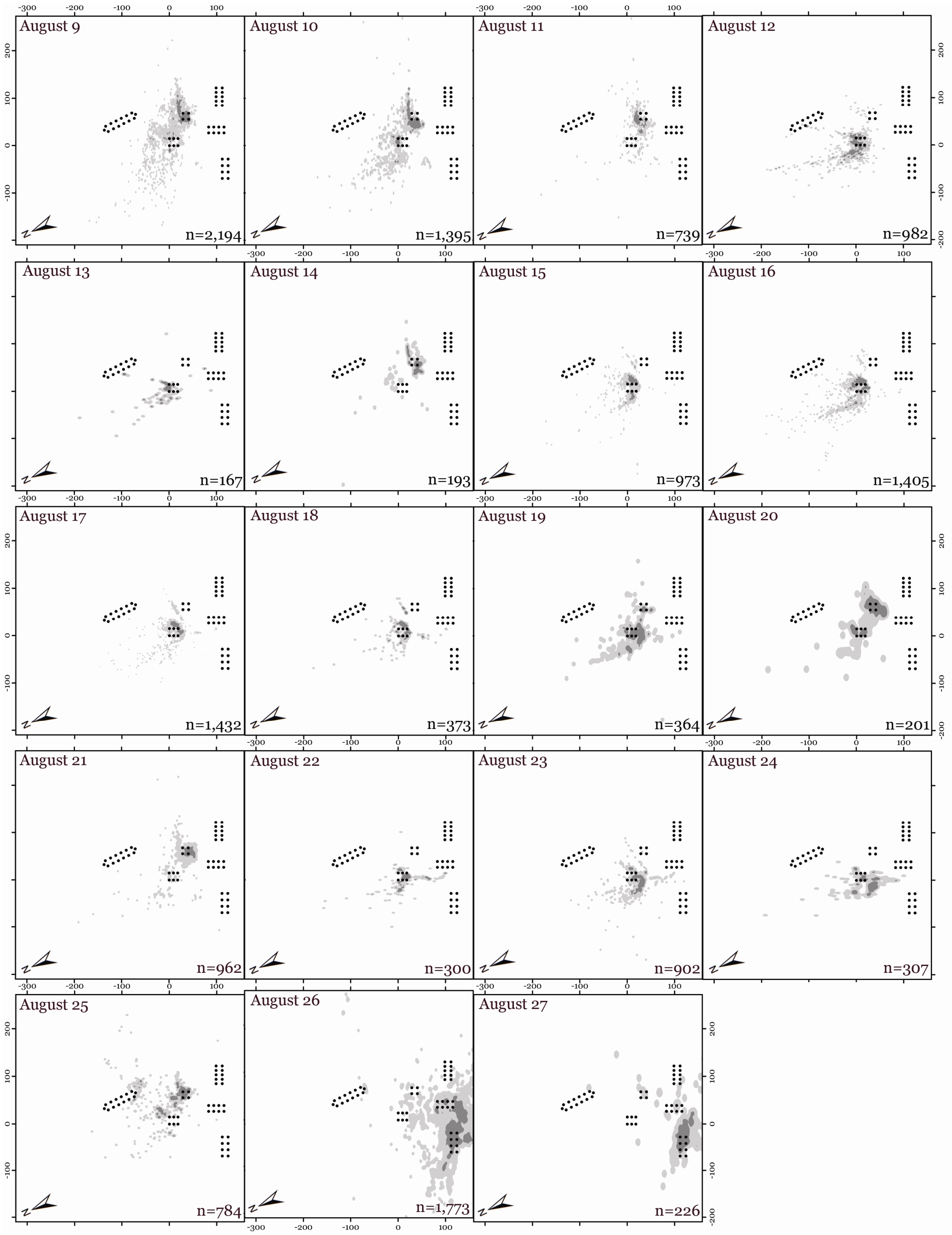


Figure E.17. The home range of tagged Fish 34200 over the period of August 9 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

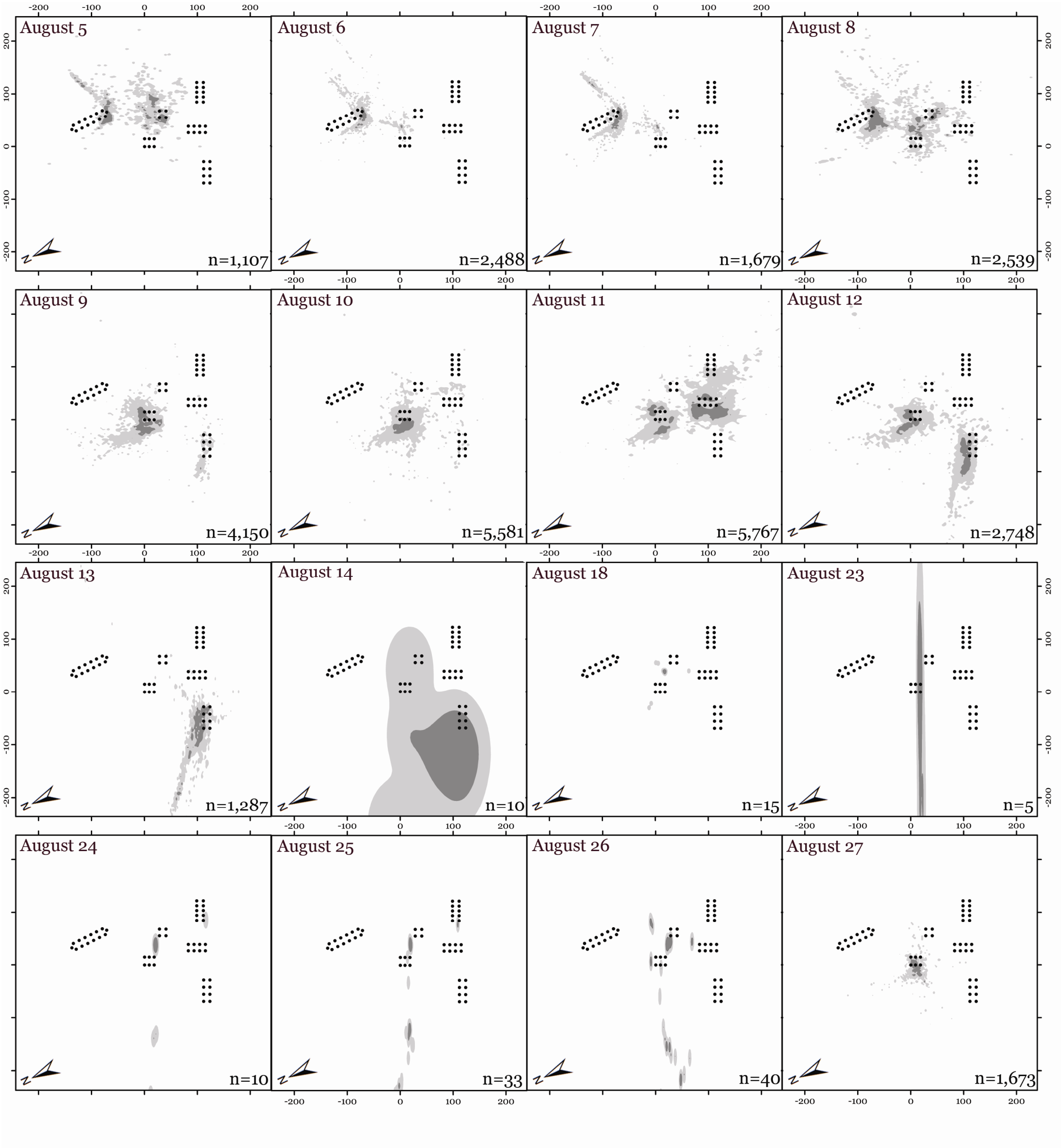


Figure E.18. The home range of tagged Fish 34300 over the period of August 5 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish. August 13 (n=0), August 16 (n=1), August 17 (n=2), August 19 (n=3), August 20 (n=), August 21 (n=3) and August 22 (n=3) are not shown due to lack of localizations during those time periods.

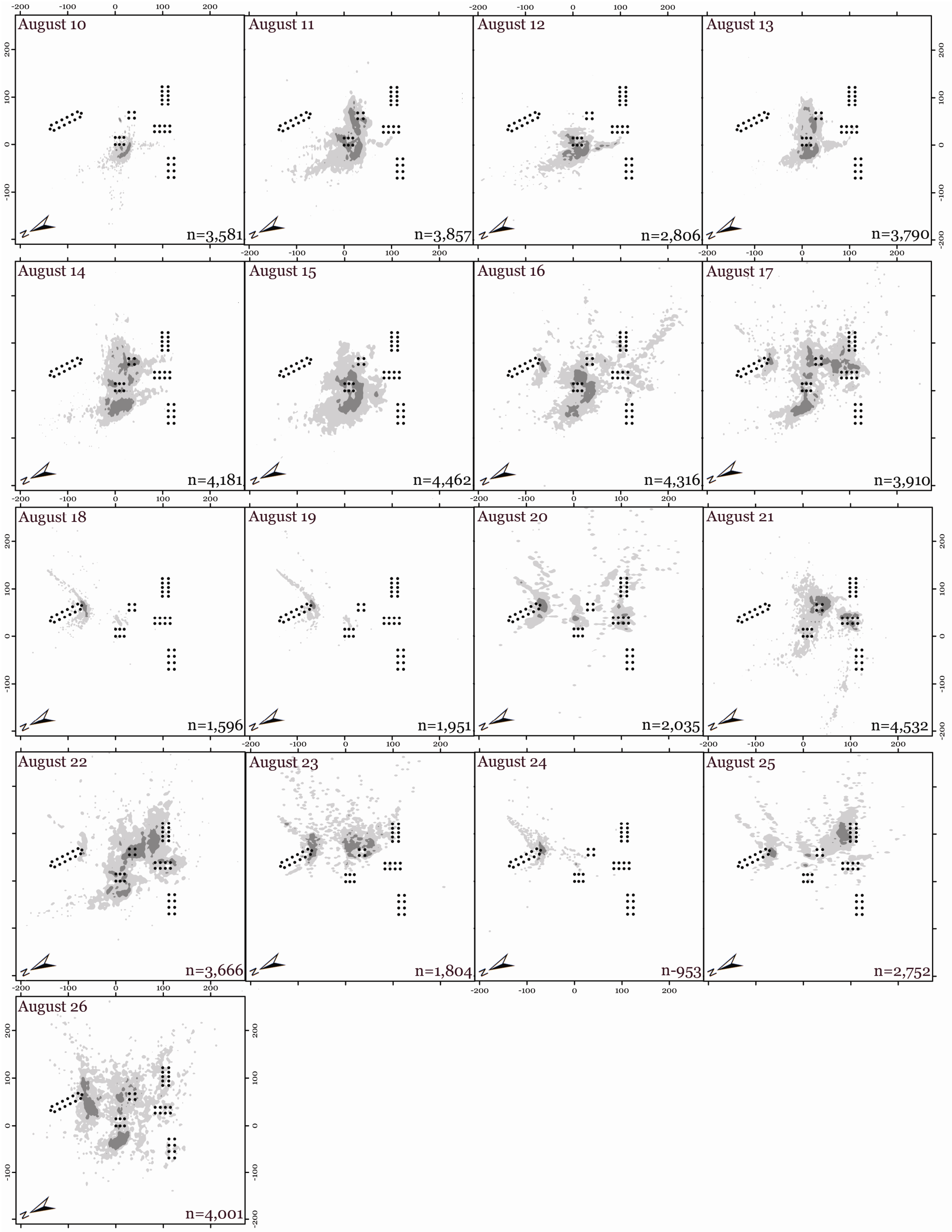


Figure E.19. The home range of tagged Fish 34600 over the period of August 9 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

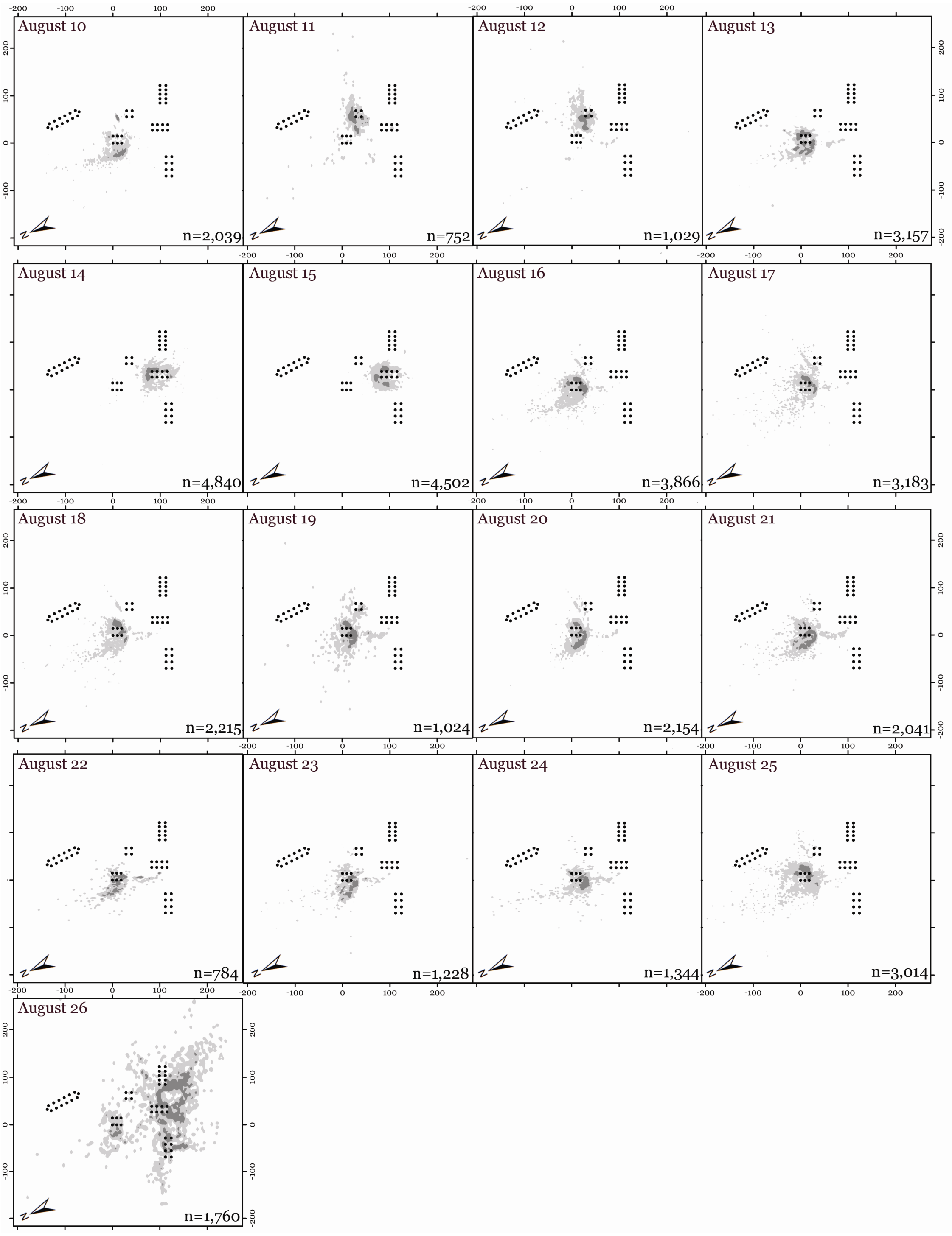


Figure E.20. The home range of tagged Fish 34800 over the period of August 9 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

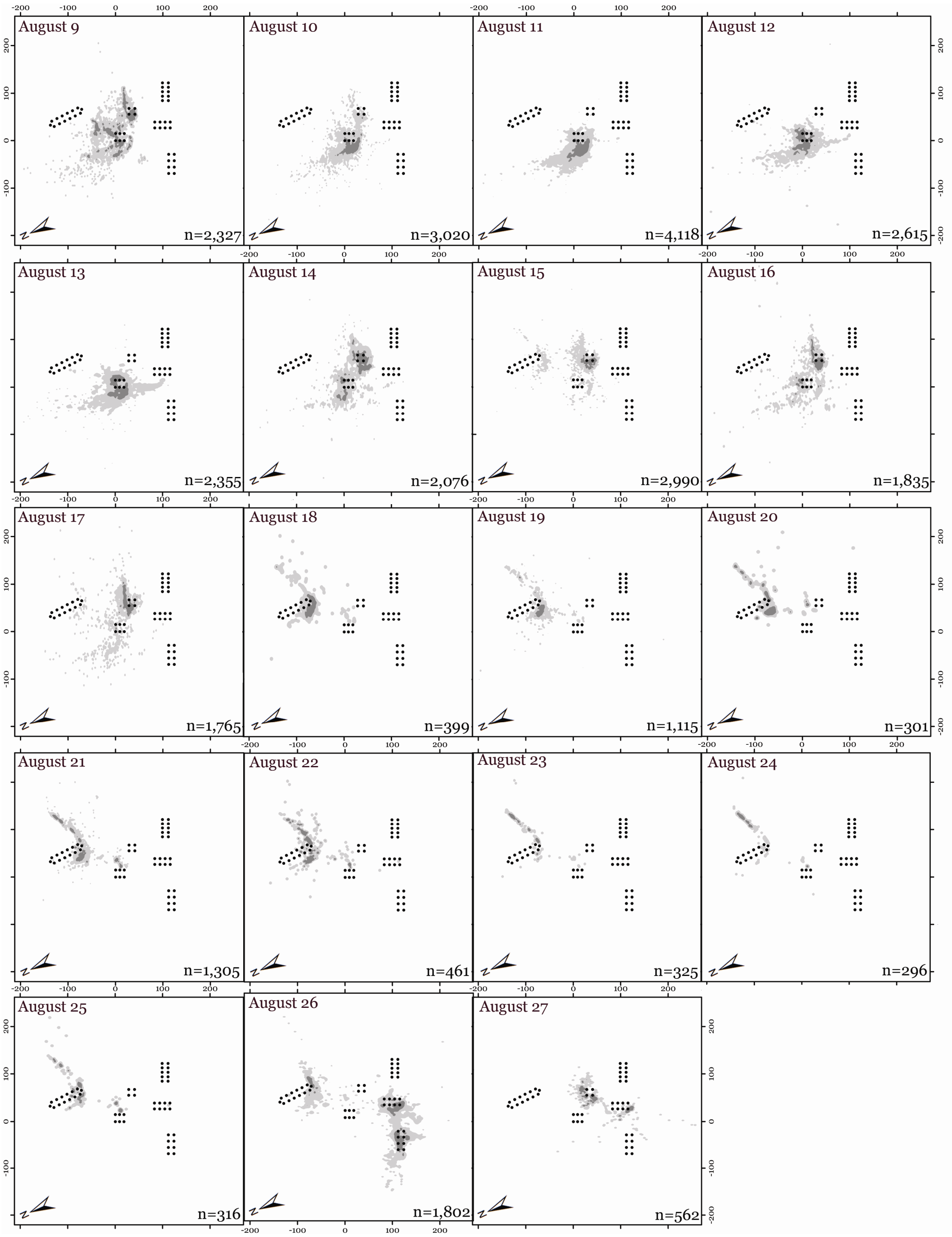


Figure E.21. The home range of tagged Fish 34900 over the period of August 9 - 27, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

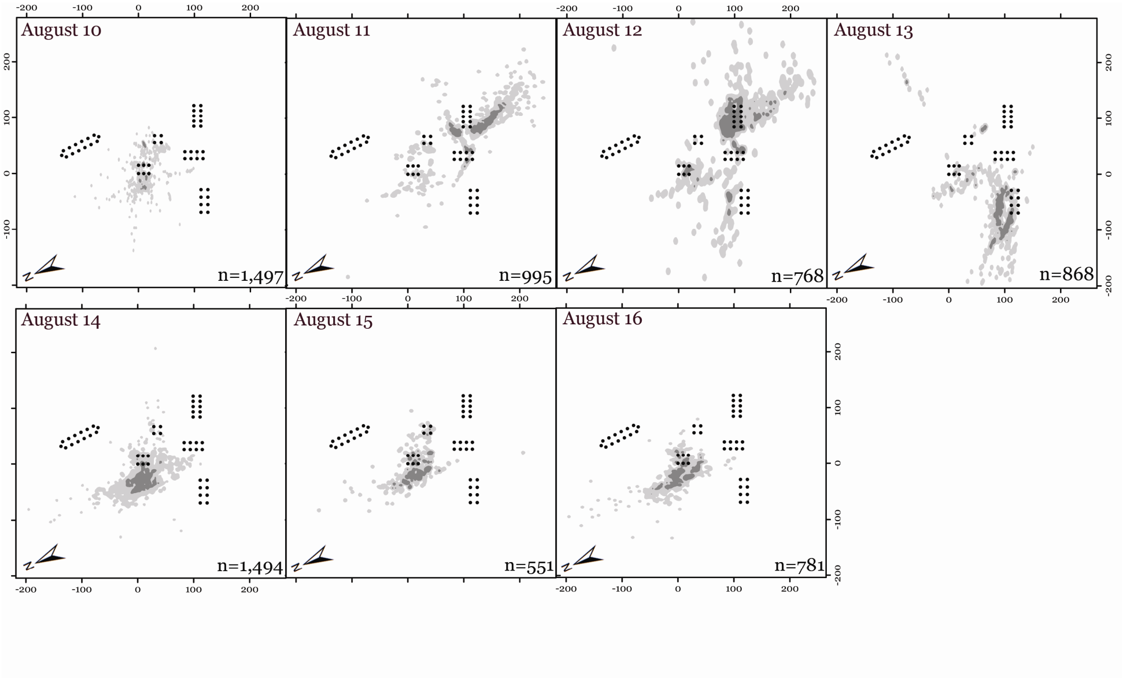


Figure E.22. The home range of tagged Fish 35000 over the period of August 10 - 16, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

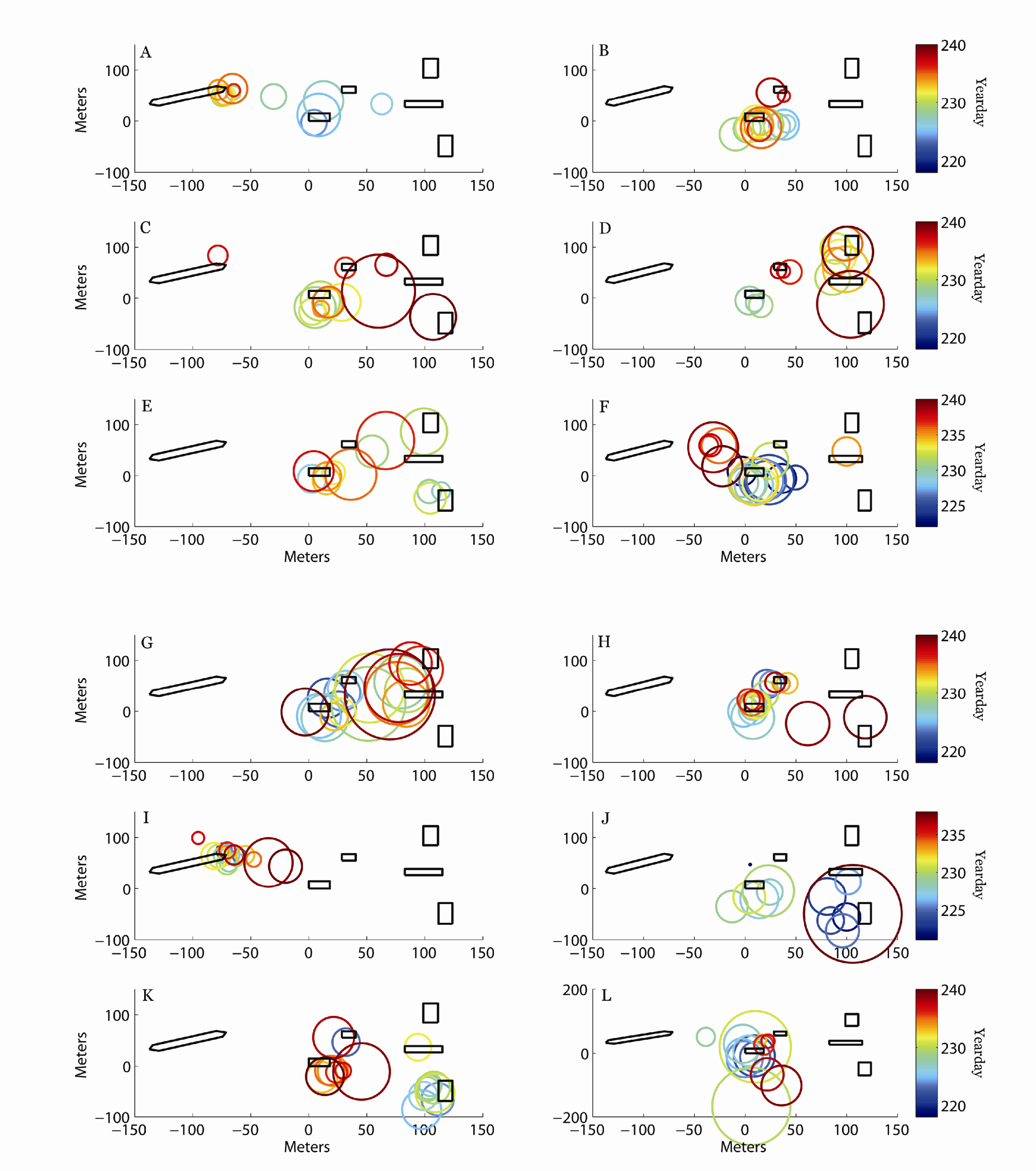


Figure E.23. Each circle represents the location and size of the daily core range of a particular fish over the length of the study period. The colors of the circles indicate yearday. A) Fish 29500, B) Fish 30200, C) Fish 30500, D) Fish 30600, E) Fish 30800, F) Fish 31300, G) Fish 31800, H) Fish 32100, I) Fish 32500, J) Fish 32700, K) Fish 32900, L) Fish 33000, M) Fish 33300, N) Fish 33500, O) Fish 33700, P) Fish 33800, Q) Fish 34000, R) Fish 34200, S) Fish 34300, T) Fish 34600, U) Fish 34800, V) Fish 34900, W) Fish 35000.

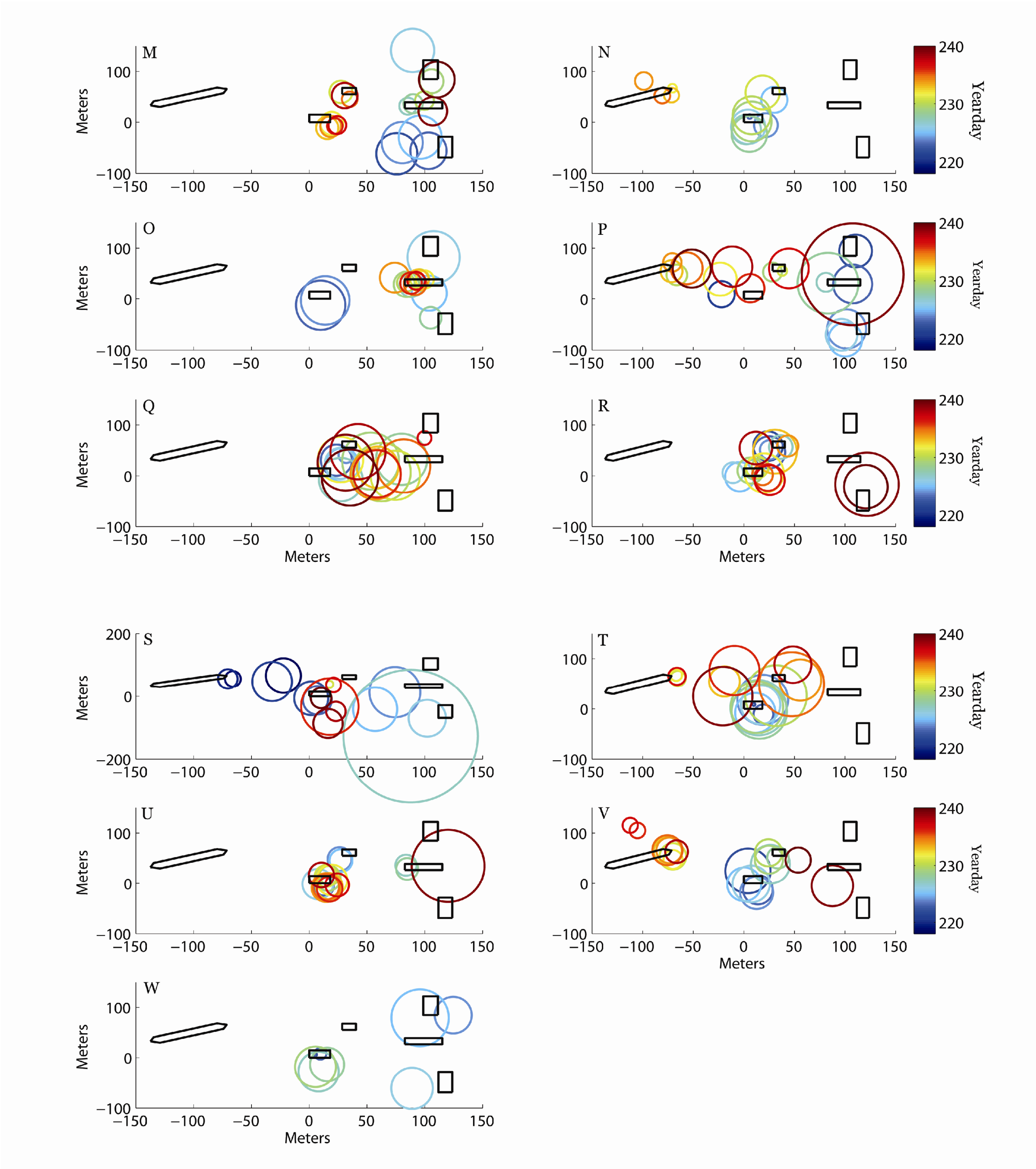


Figure E.23 (continuted)

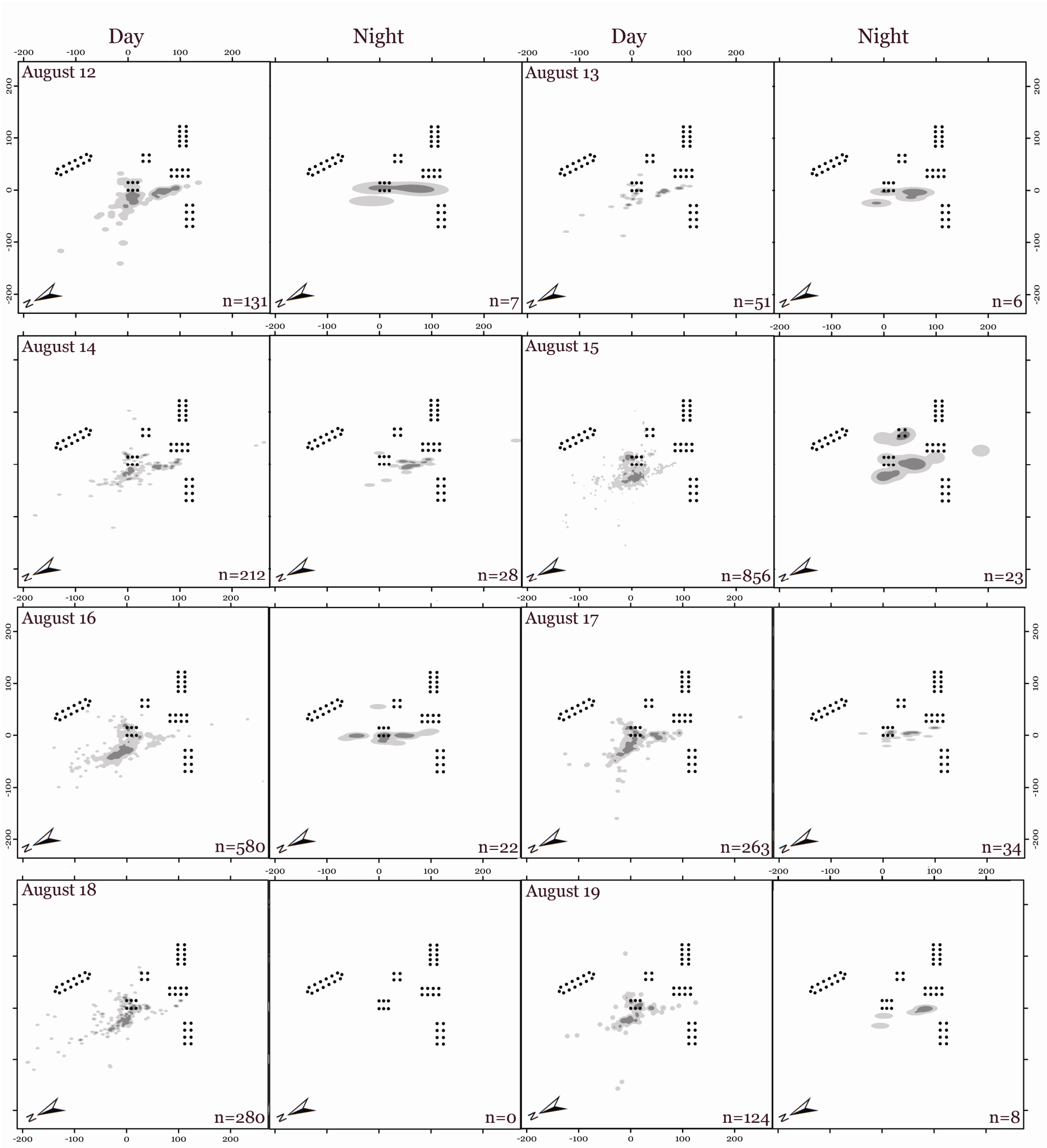


Figure E.24. The day and night home range of tagged Fish 30200 over the period of August 12 - 25, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

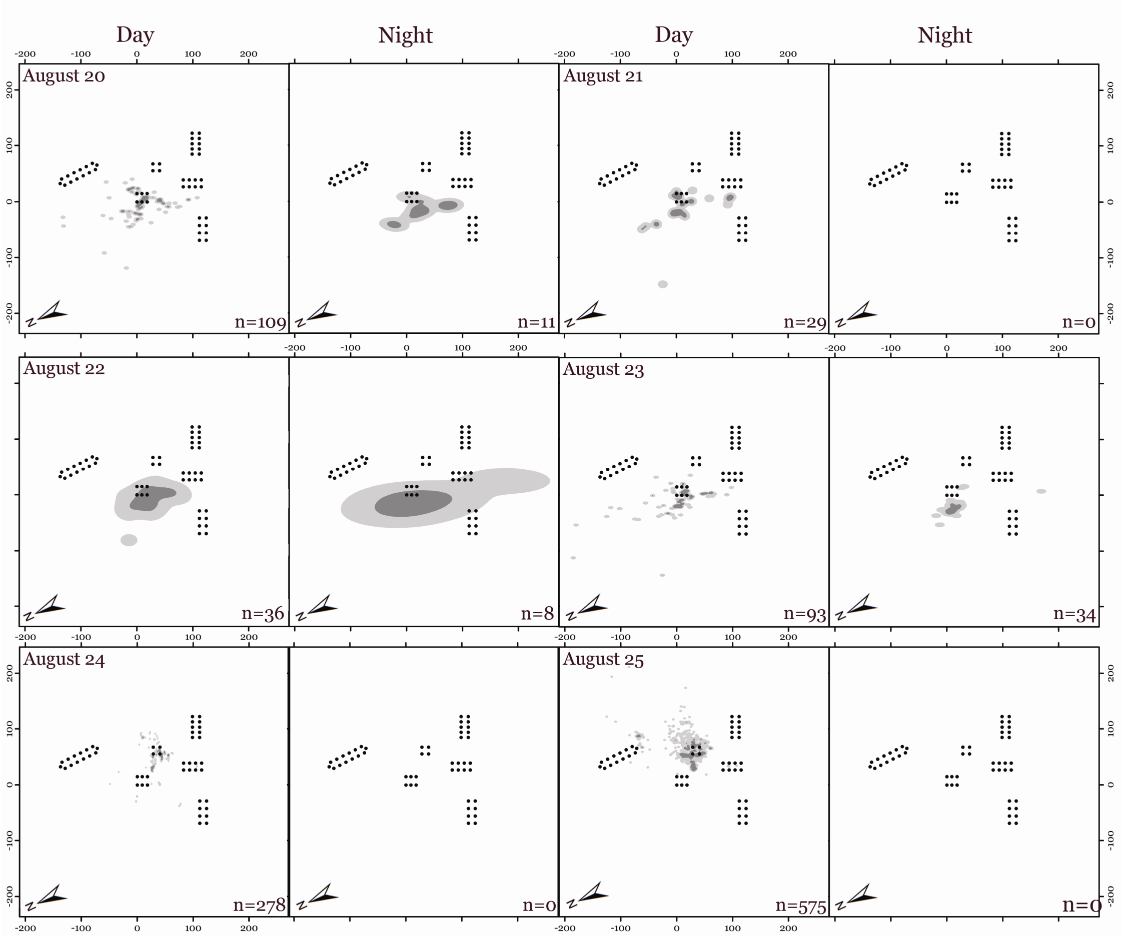


Figure E.24 (continued)

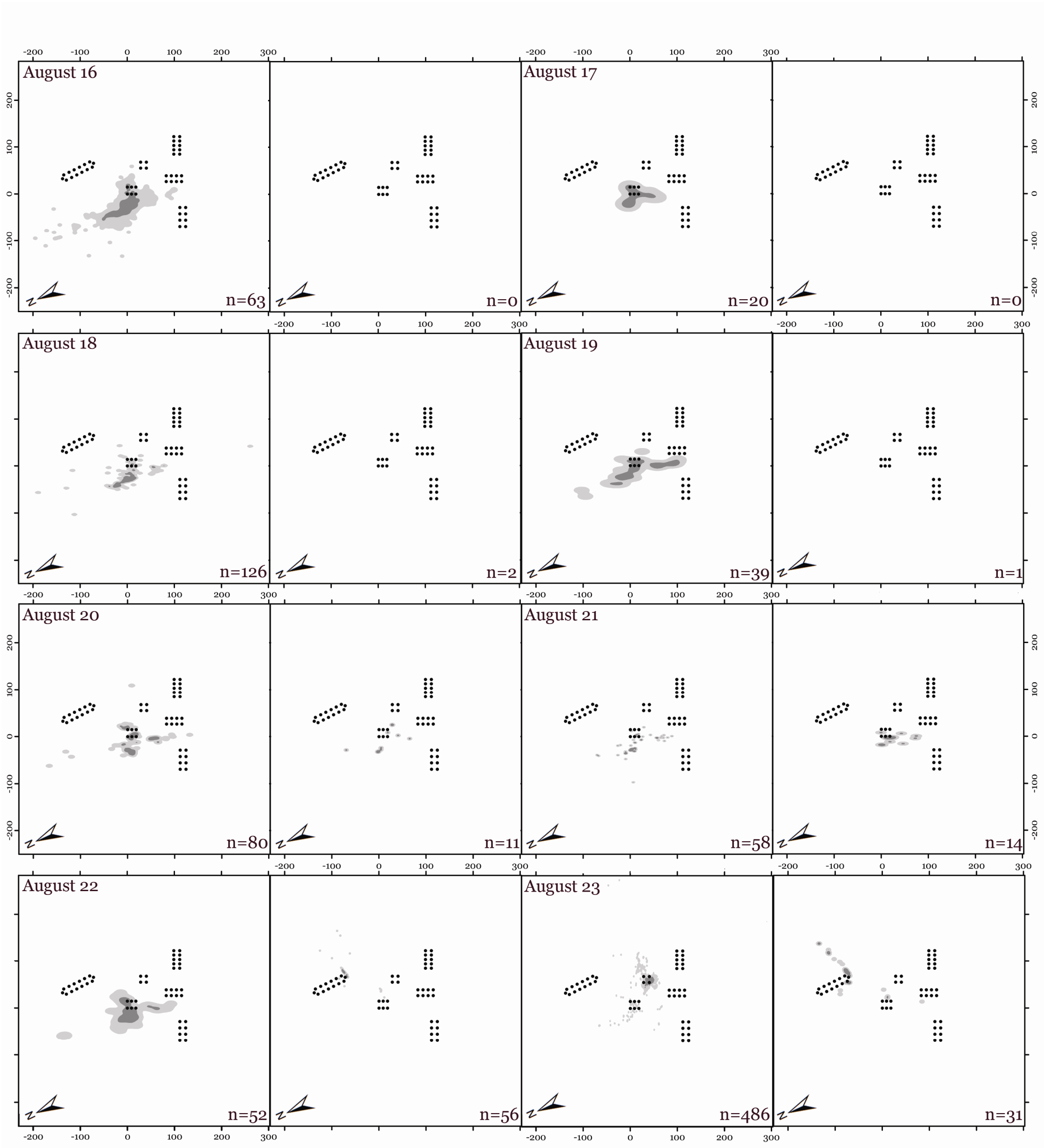


Figure E.25. The day and night home range of tagged Fish 30500 over the period of August 16 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

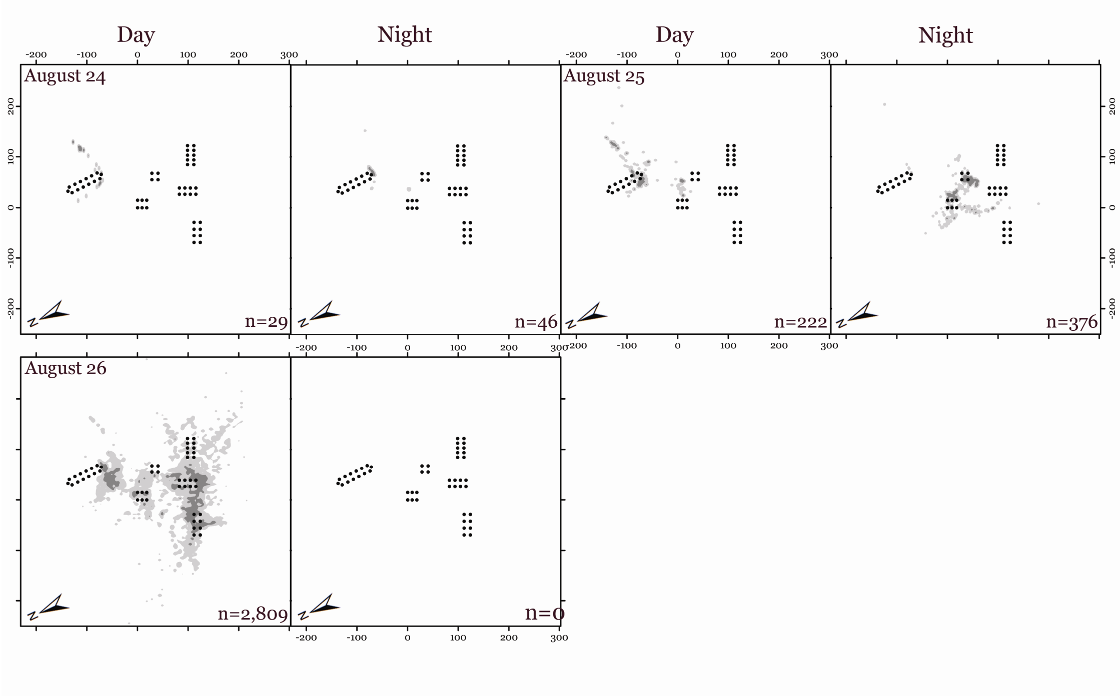


Figure E.25 (continued)

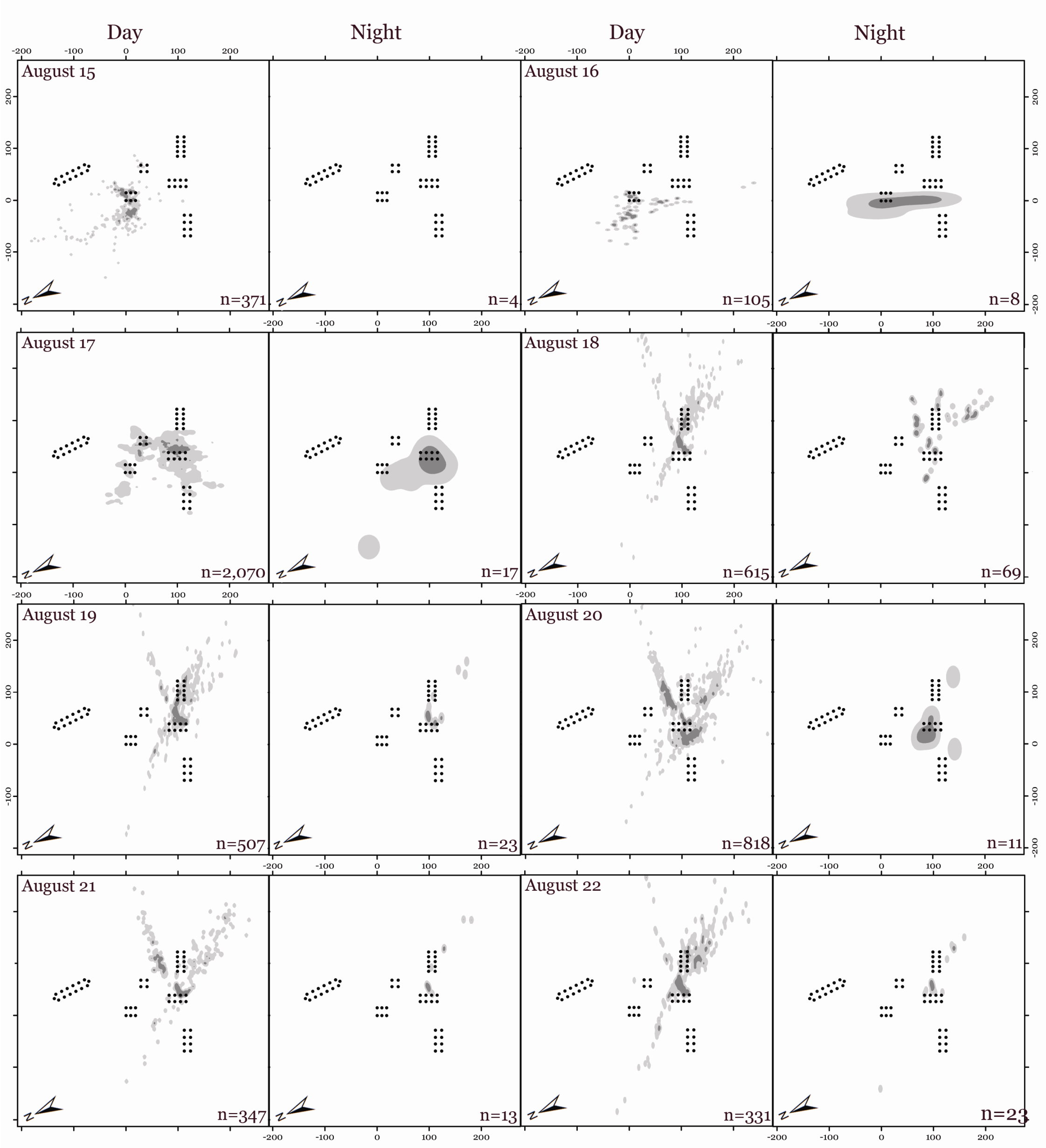


Figure E.26. The day and night home range of tagged Fish 30600 over the period of August 15 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

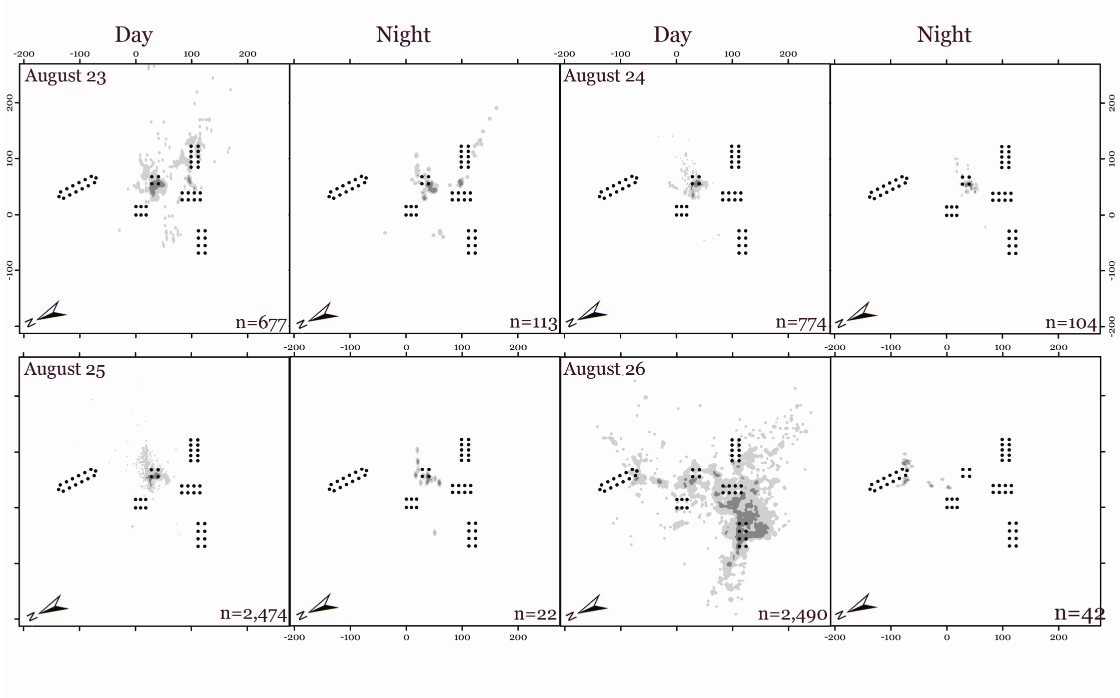


Figure E.26 (continued)

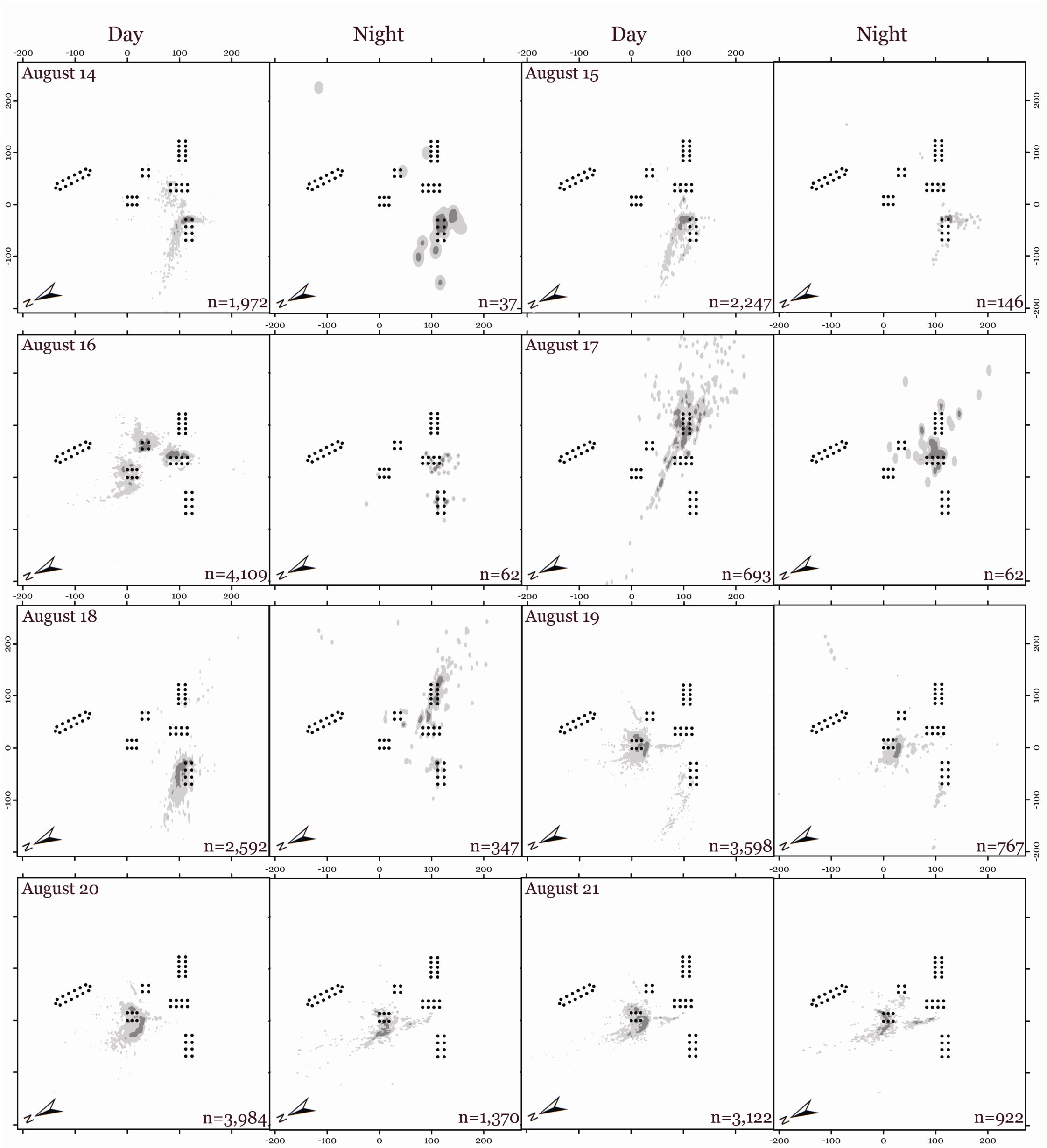


Figure E.27. The day and night home range of tagged Fish 30800 over the period of August 14 - 24, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

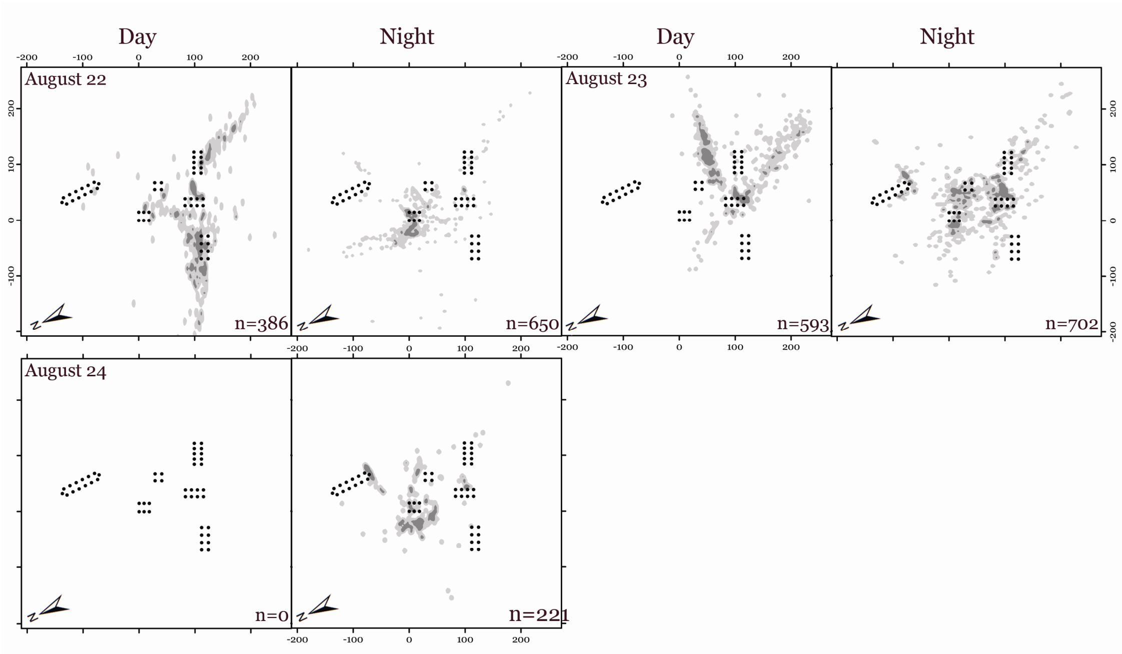


Figure E.27 (continued)

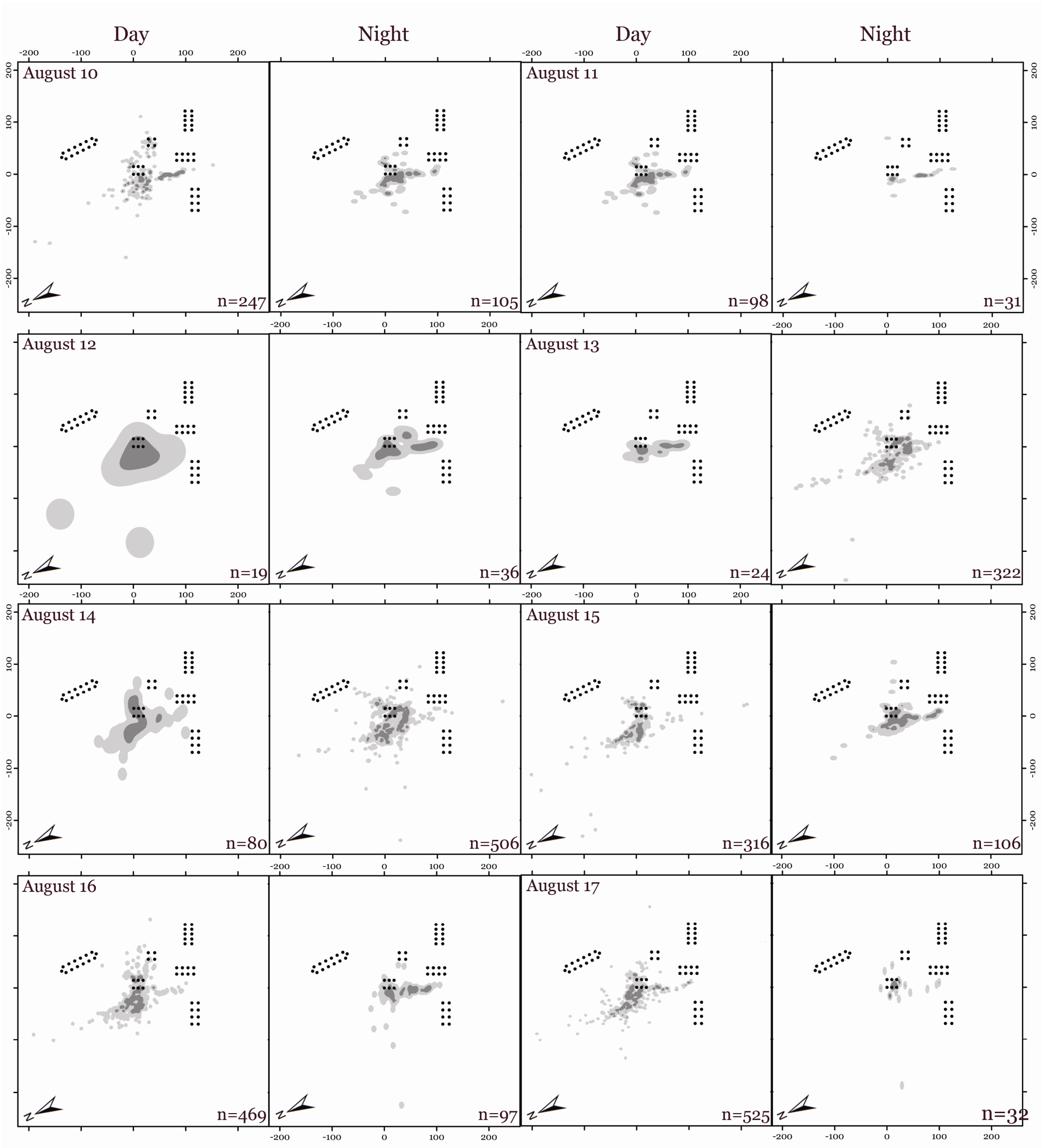


Figure E.28. The day and night home range of tagged Fish 31300 over the period of August 10 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

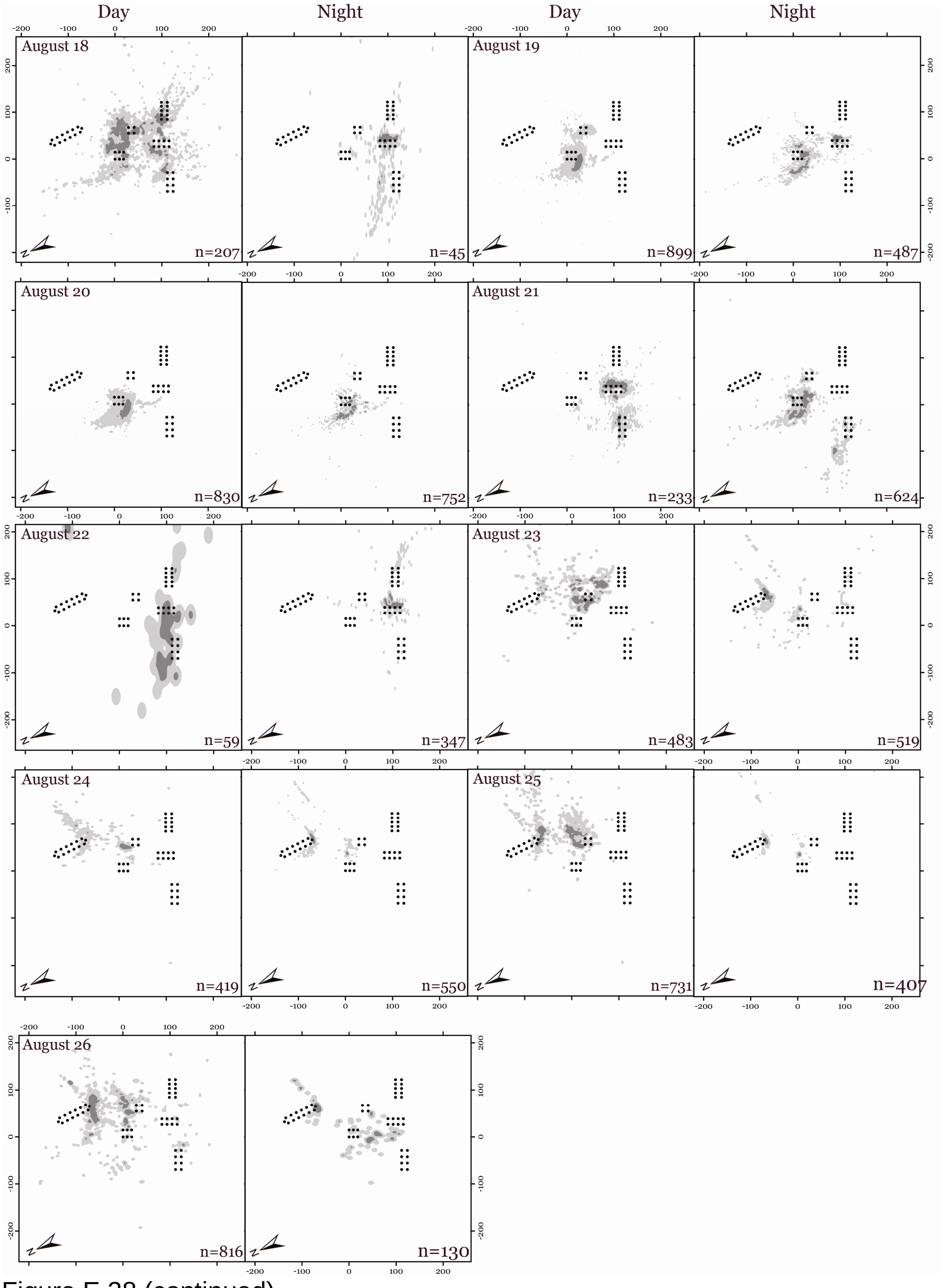


Figure E.28 (continued)

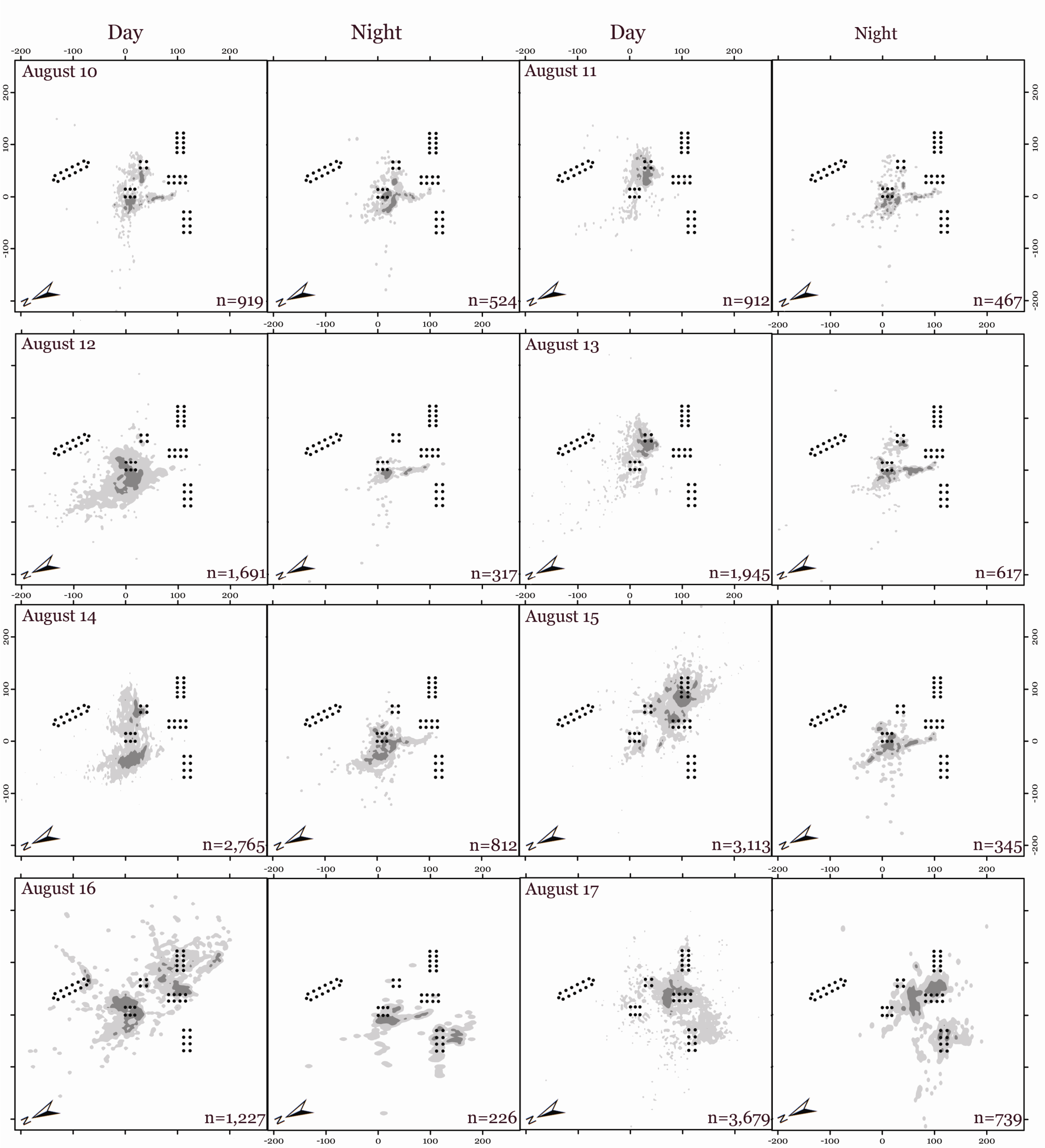


Figure E.29. The day and night home range of tagged Fish 31800 over the period of August 10 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

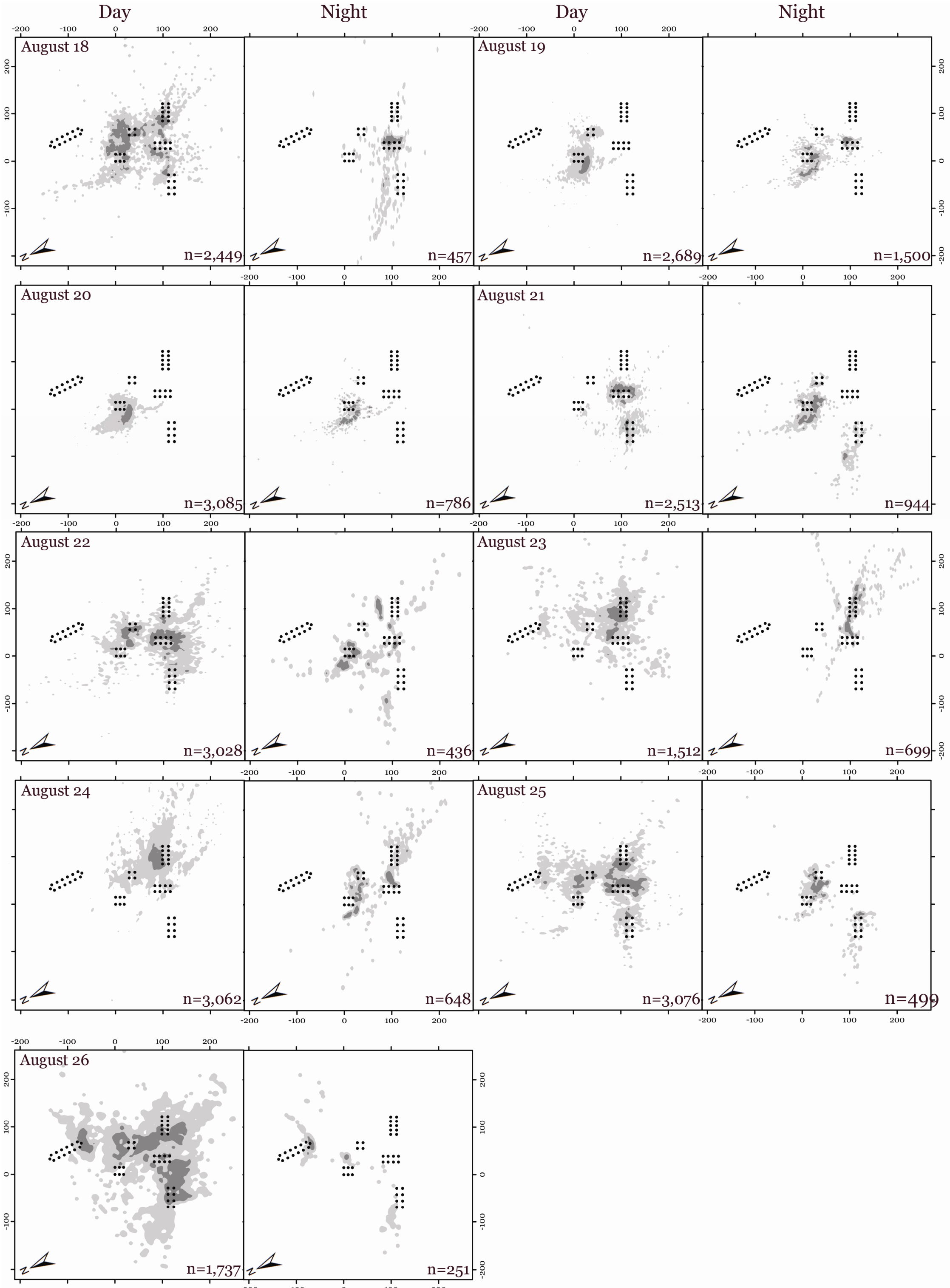


Figure E.29 (continued)

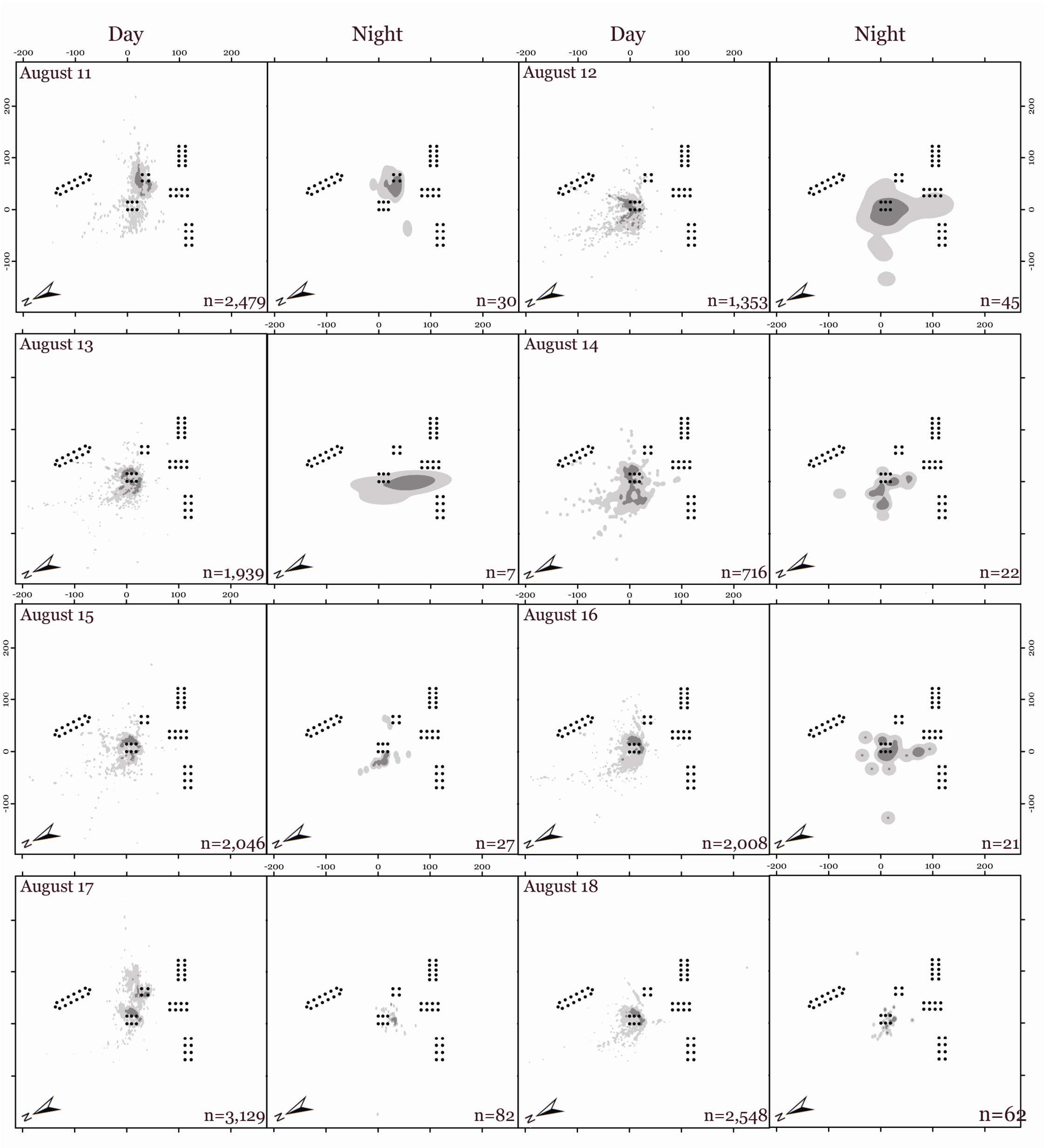
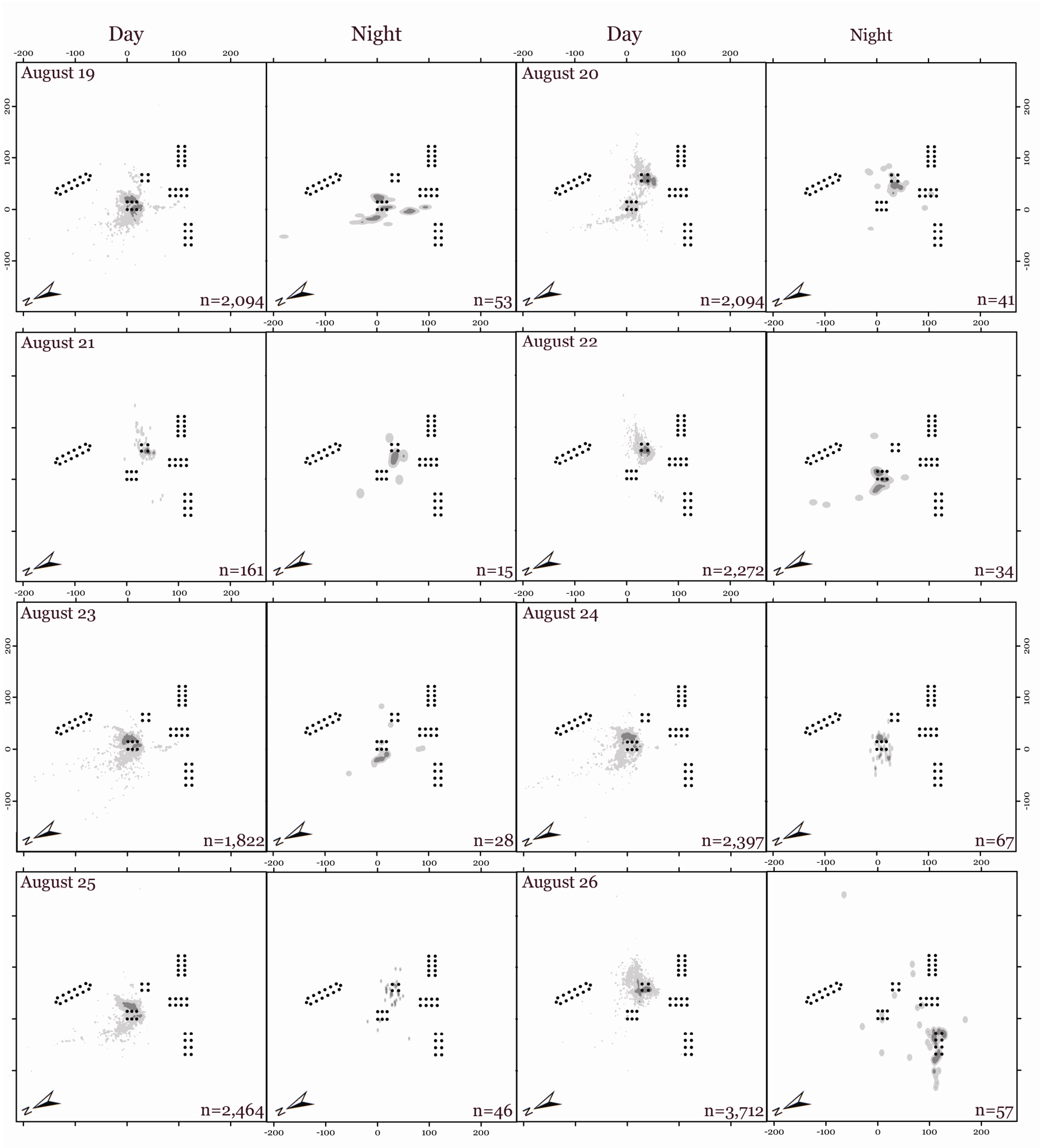


Figure E.30. The day and night home range of tagged Fish 32100 over the period of August 11 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.



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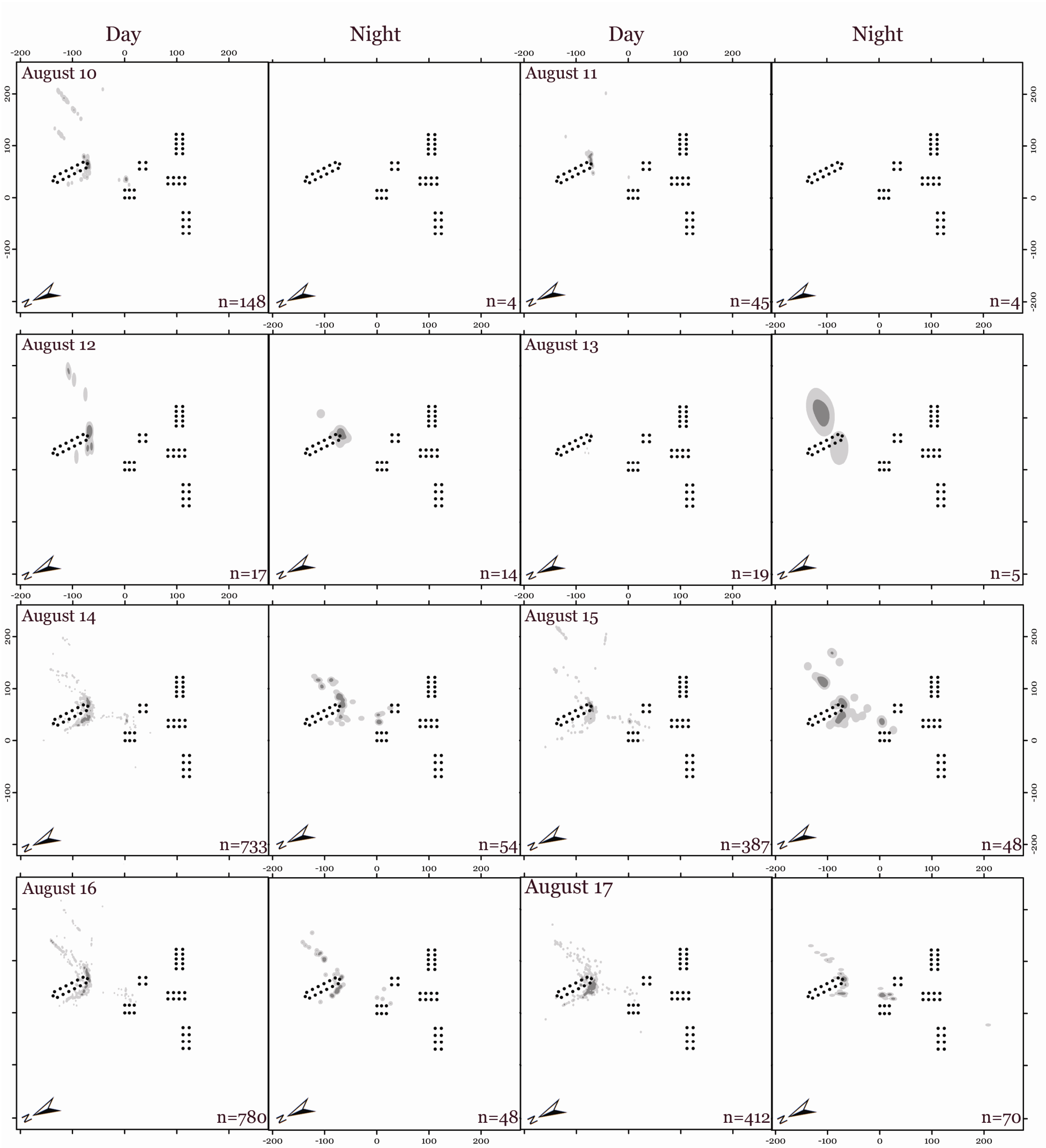
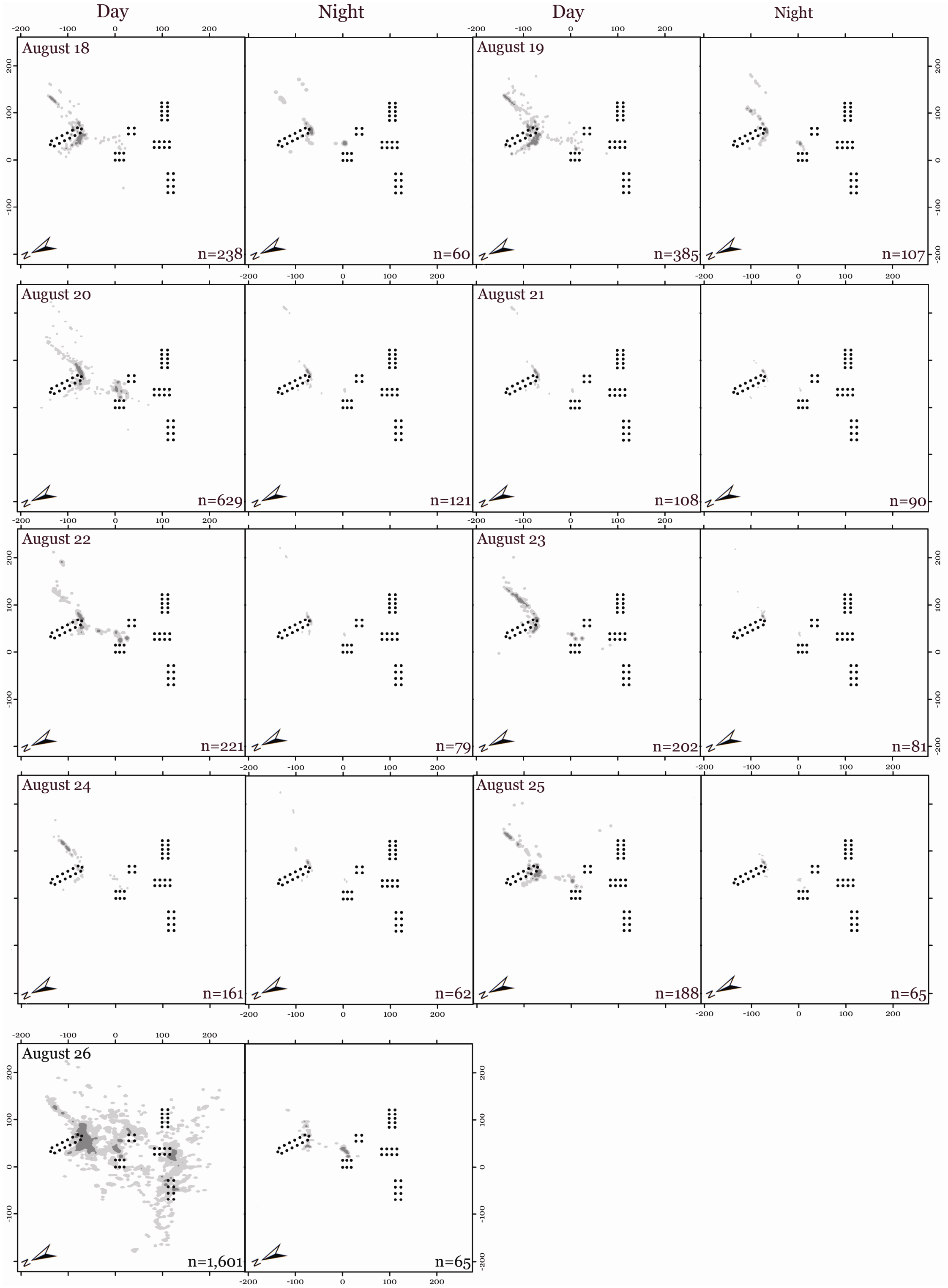


Figure E.31. The day and night home range of tagged Fish 32500 over the period of August 10 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.



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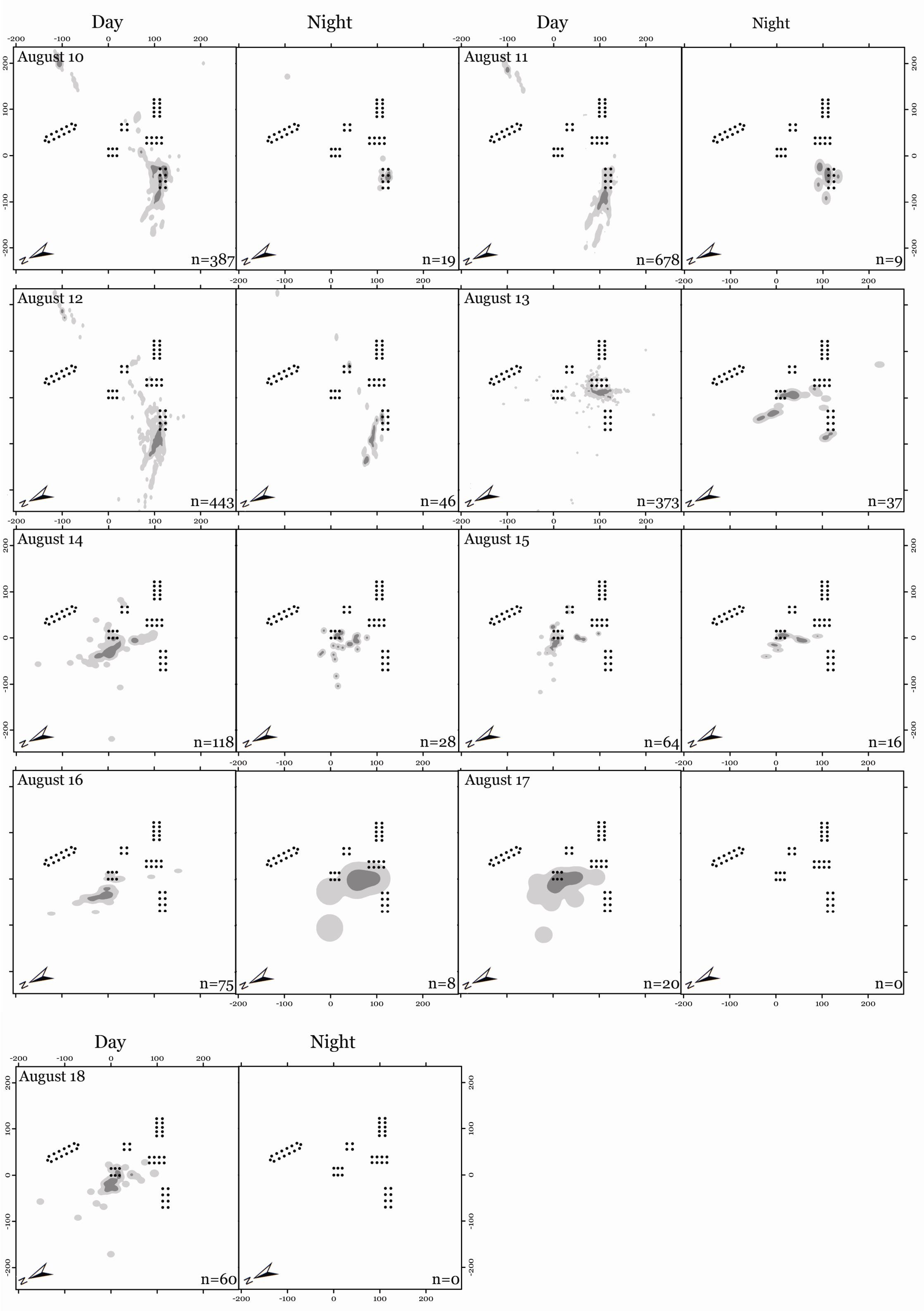


Figure E3.2. The day and night home range of tagged Fish 32700 over the period of August 10 - 18, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

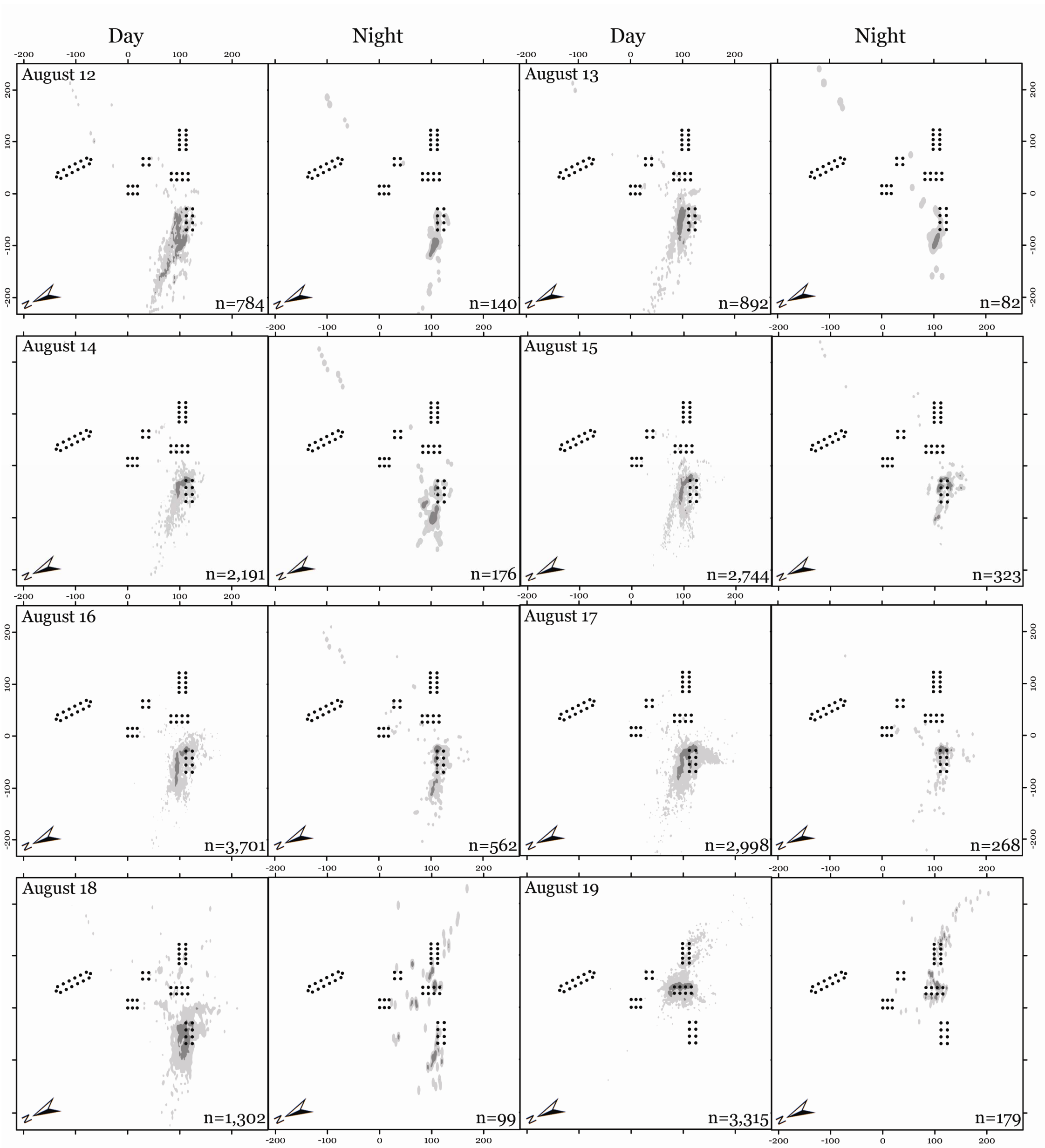
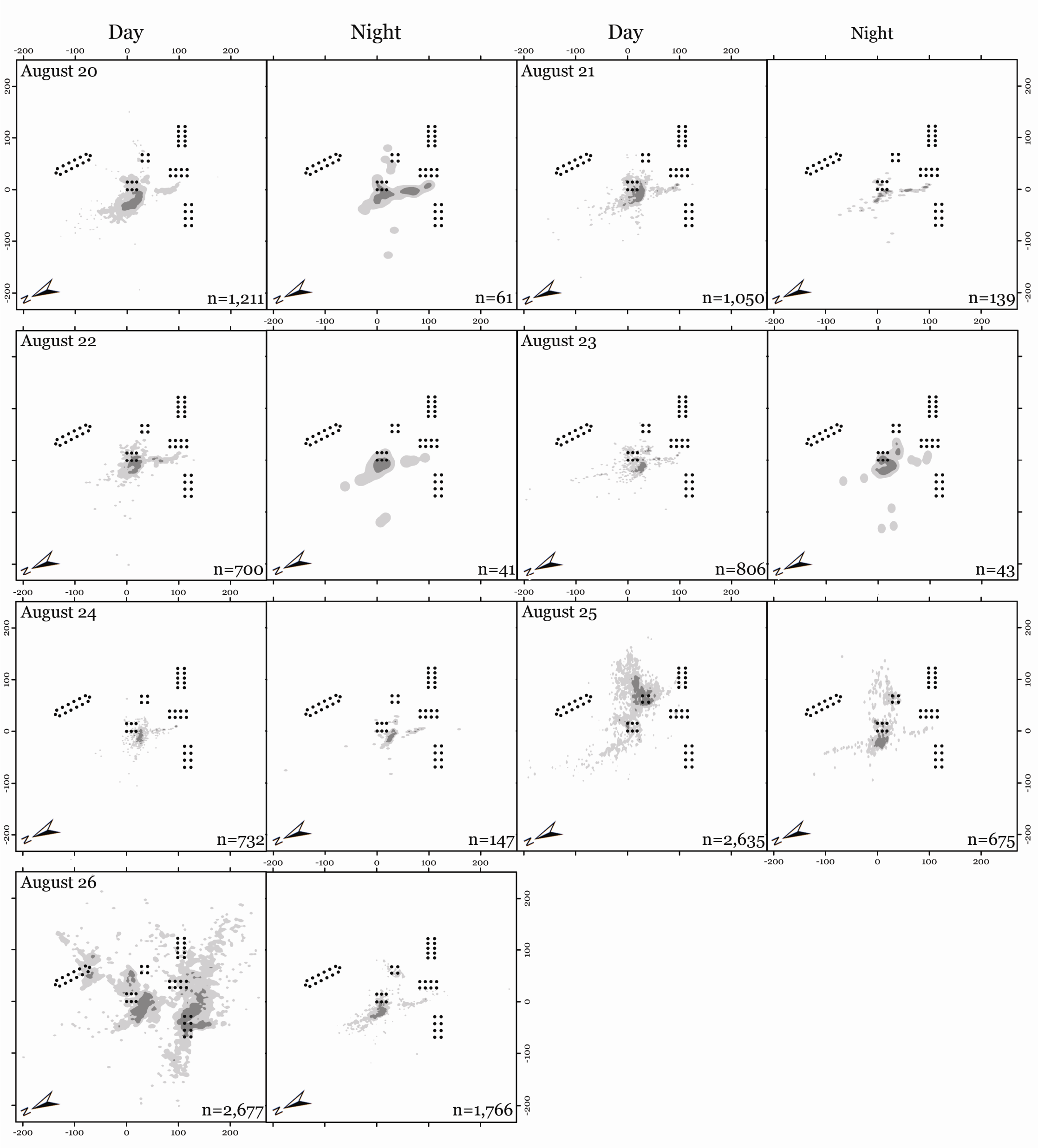


Figure E.33. The day and night home range of tagged Fish 32900 over the period of August 12 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.



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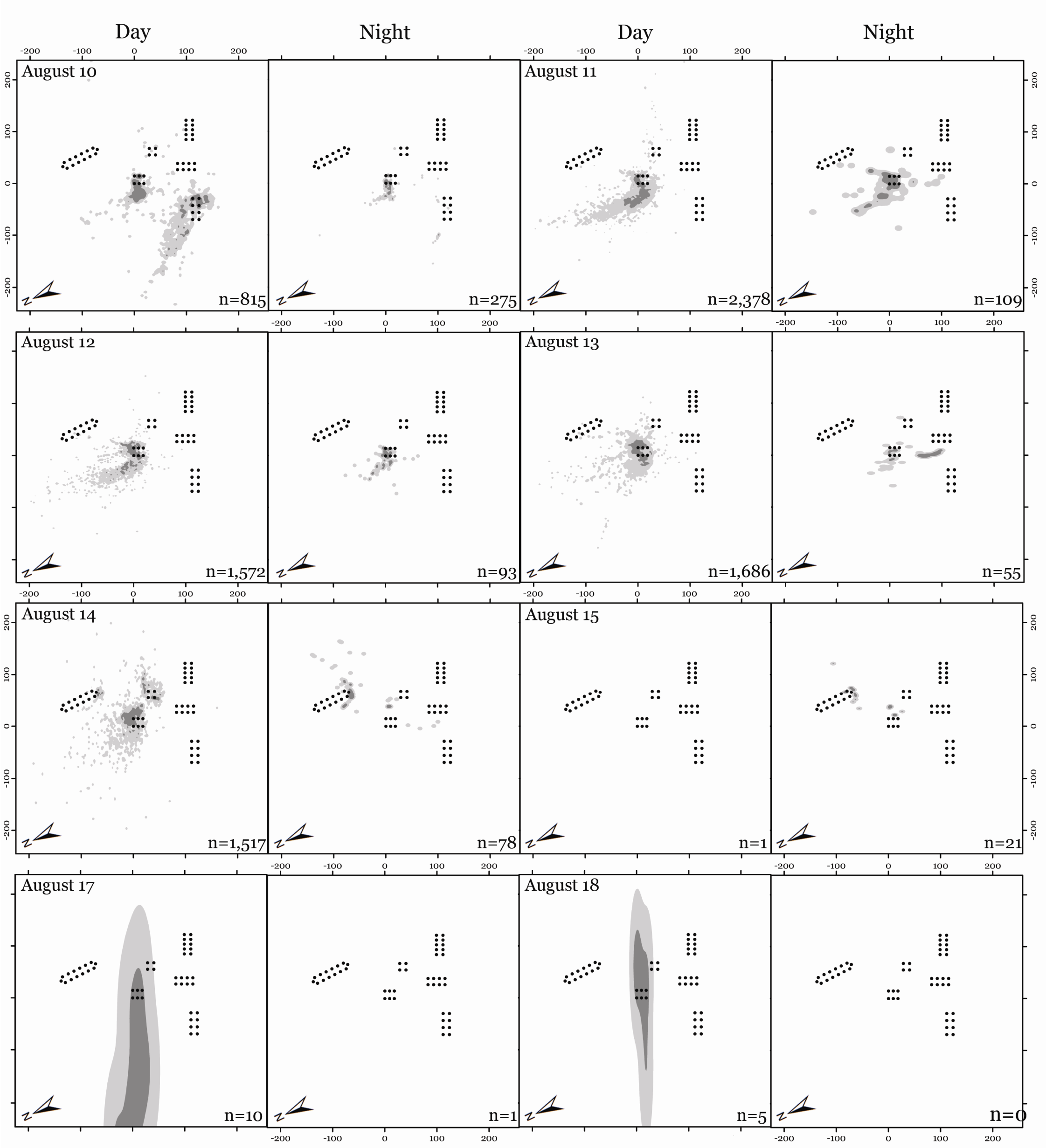


Figure E.34. The day and night home range of tagged Fish 33000 over the period of August 10 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish. August 16 (day n=1, night n=0), August 19 (day n=2, night n=0), August 21 (day n=3, night n=0), and August 22 (n=0) are not shown due to lack of localizations during those time periods.

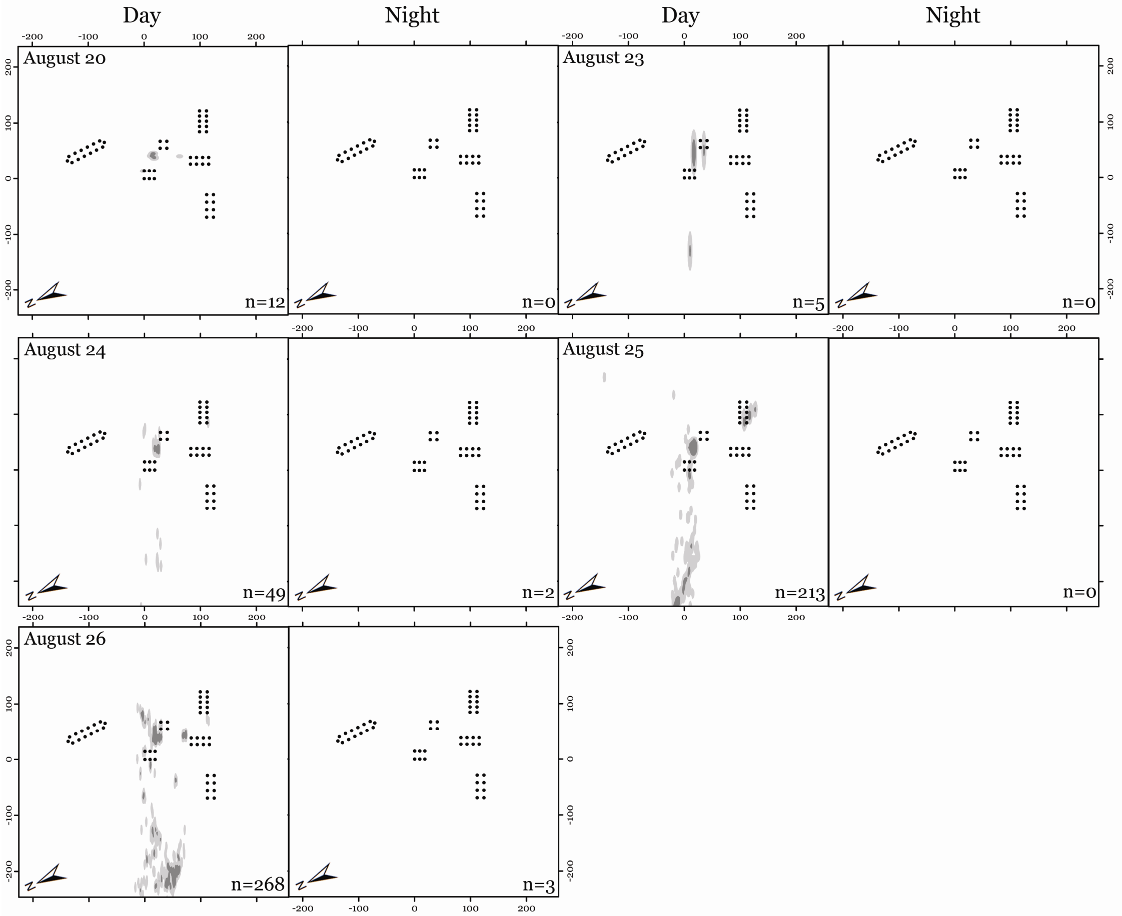


Figure E.34 (continued)

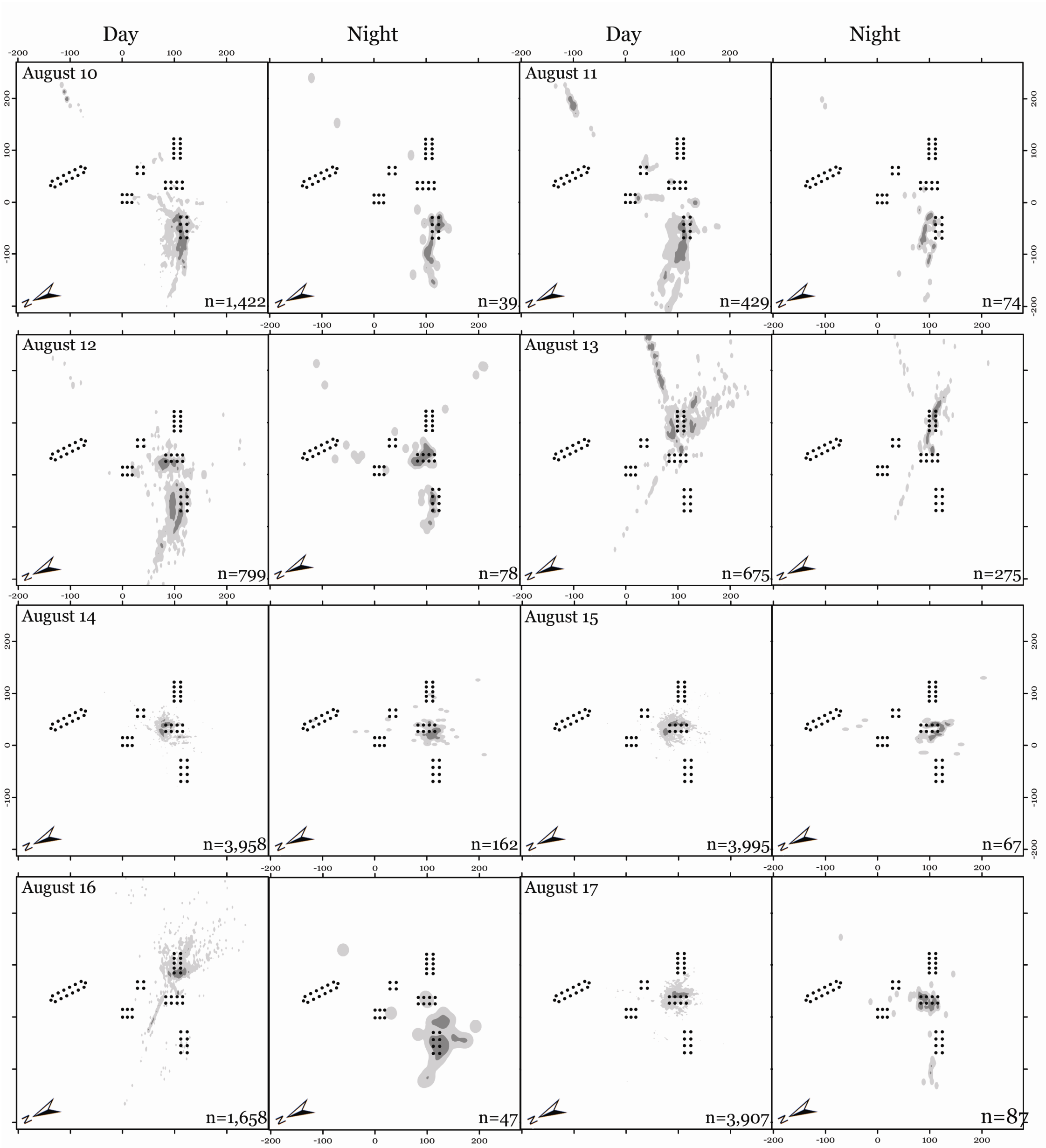
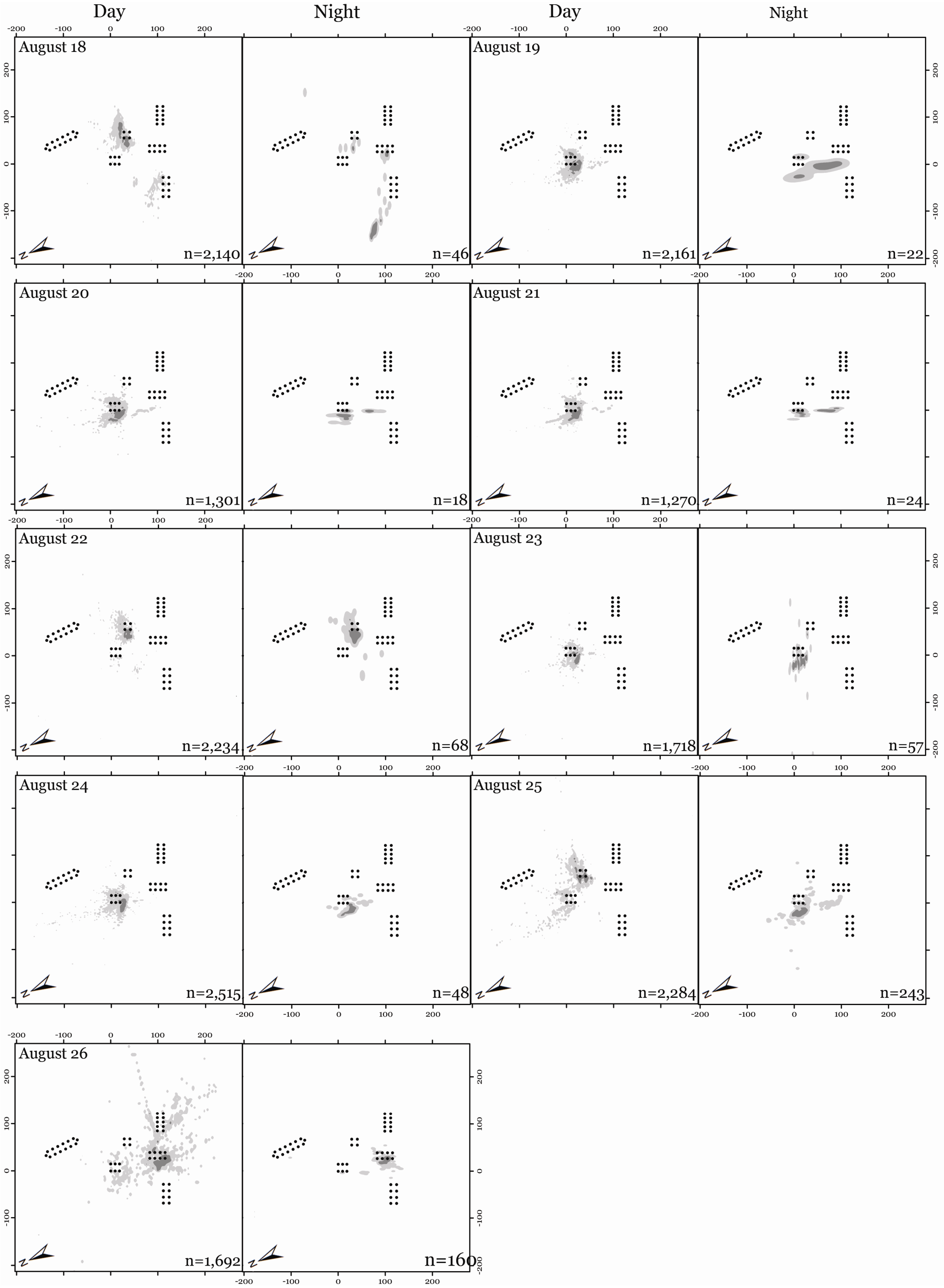


Figure E.35. The day and night home range of tagged Fish 33300 over the period of August 10 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.



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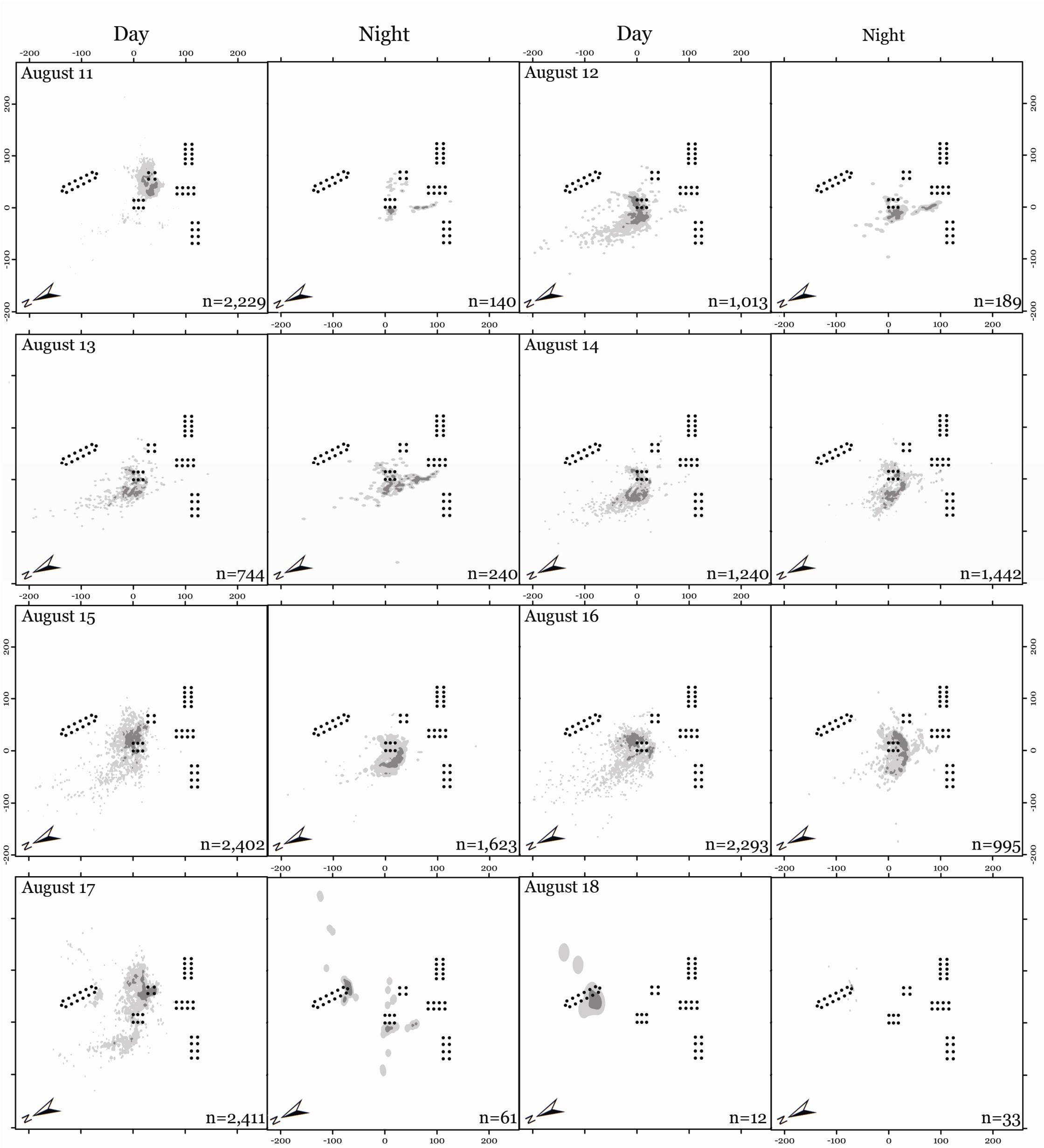
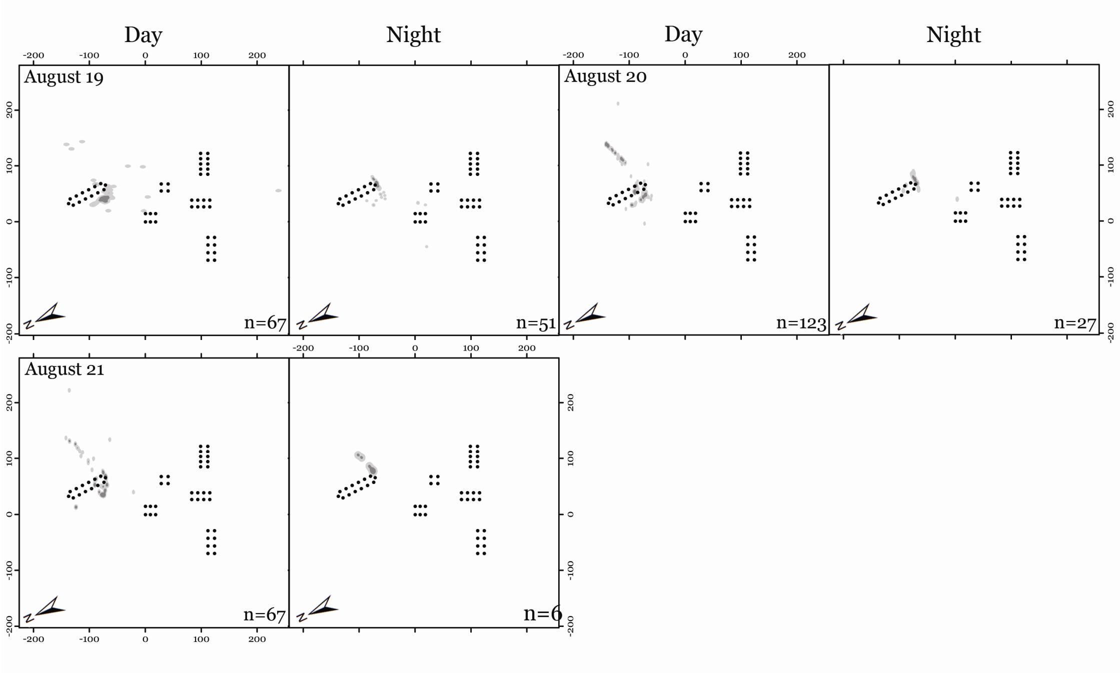


Figure E.36. The day and night home range of tagged Fish 33500 over the period of August 11 - 21, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.



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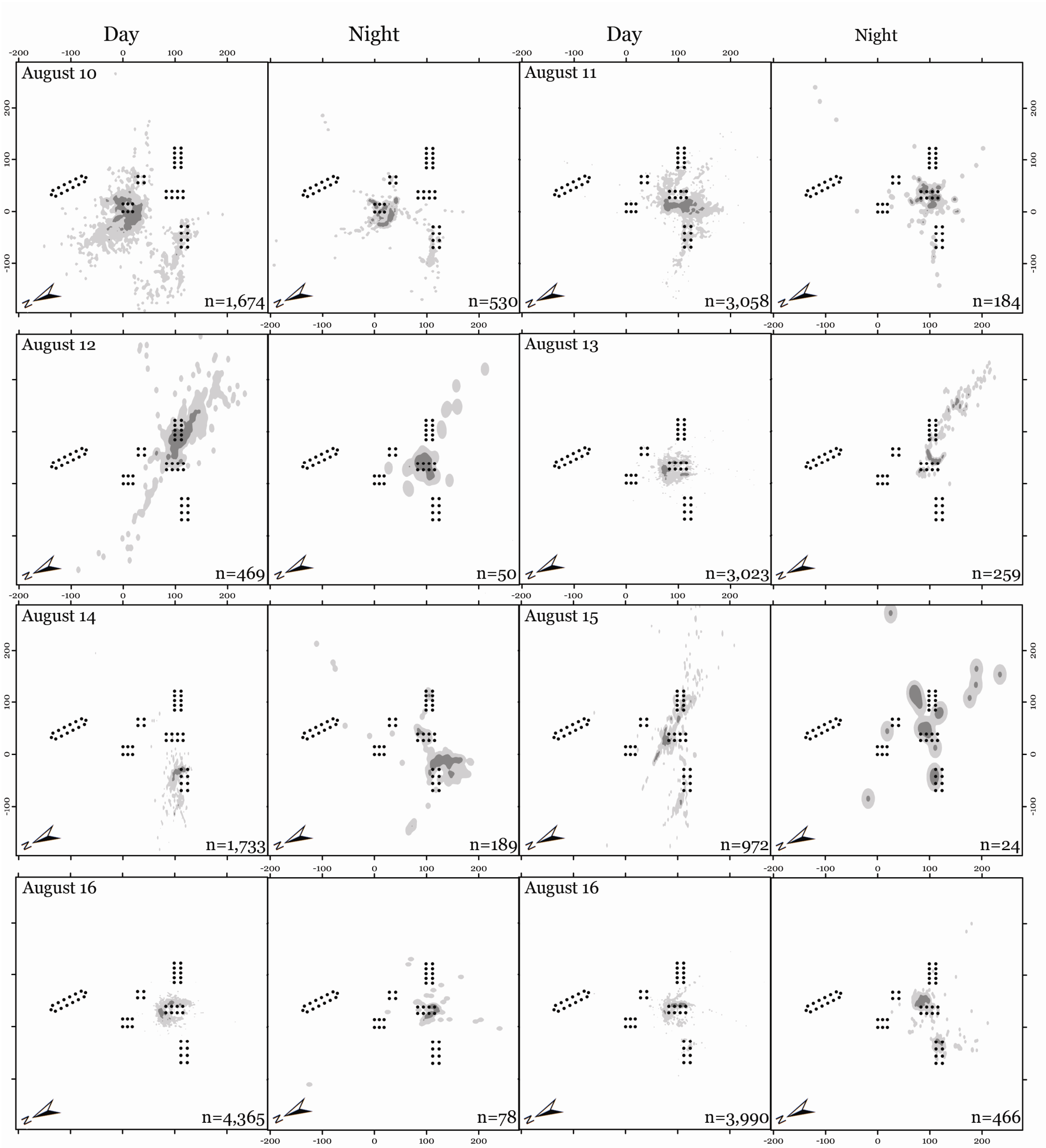
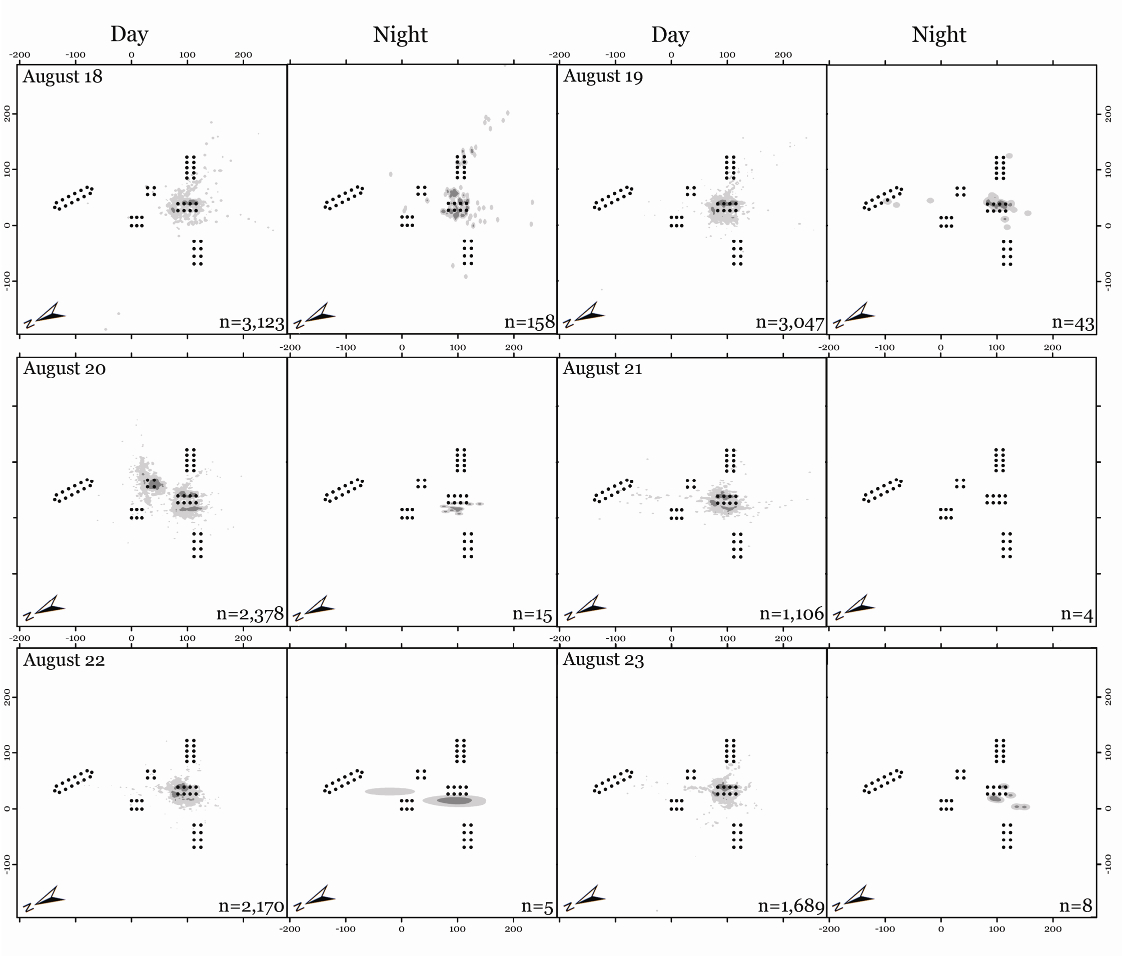


Figure E.37. The day and night home range of tagged Fish 33700 over the period of August 10 - 23, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.



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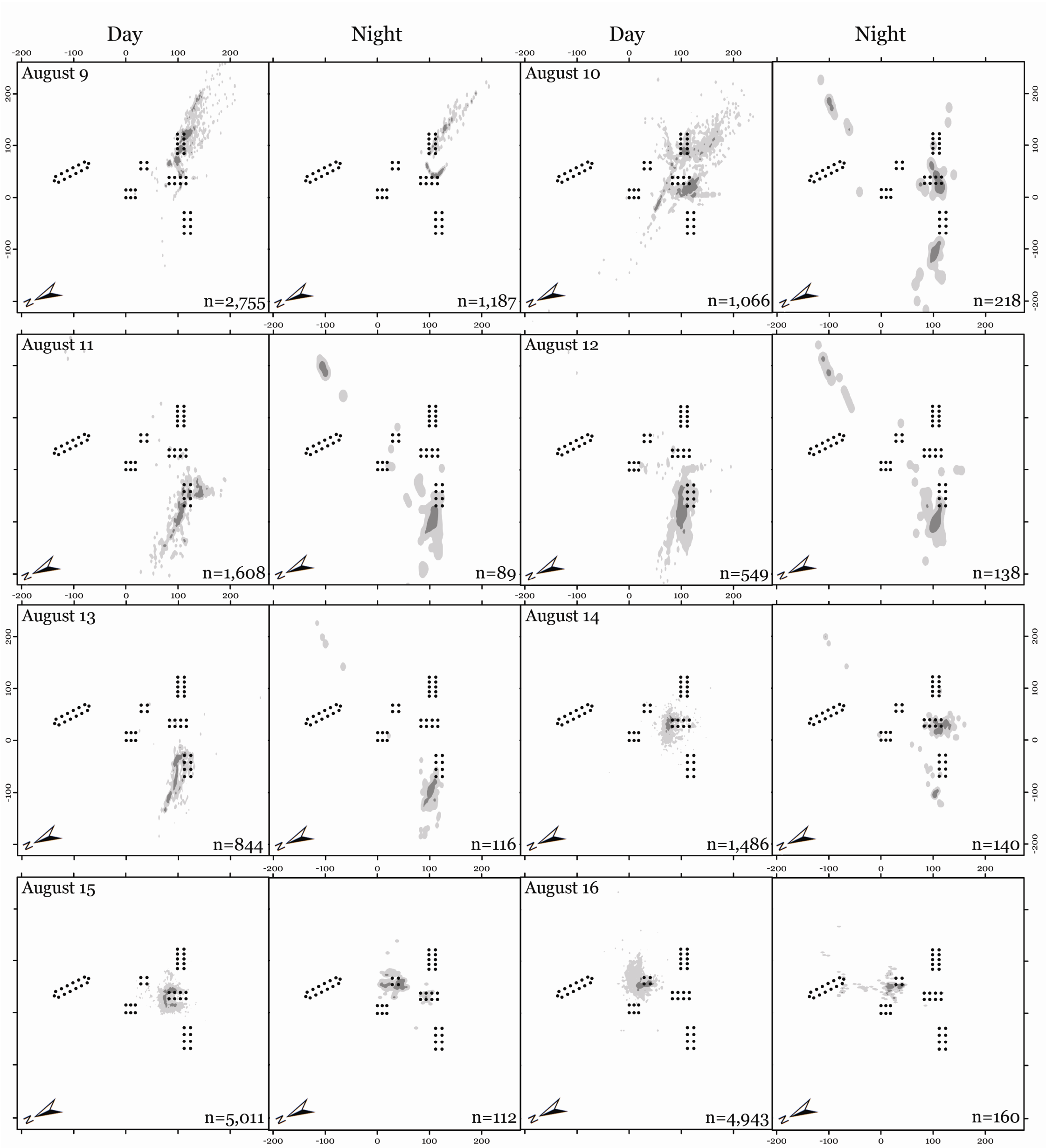
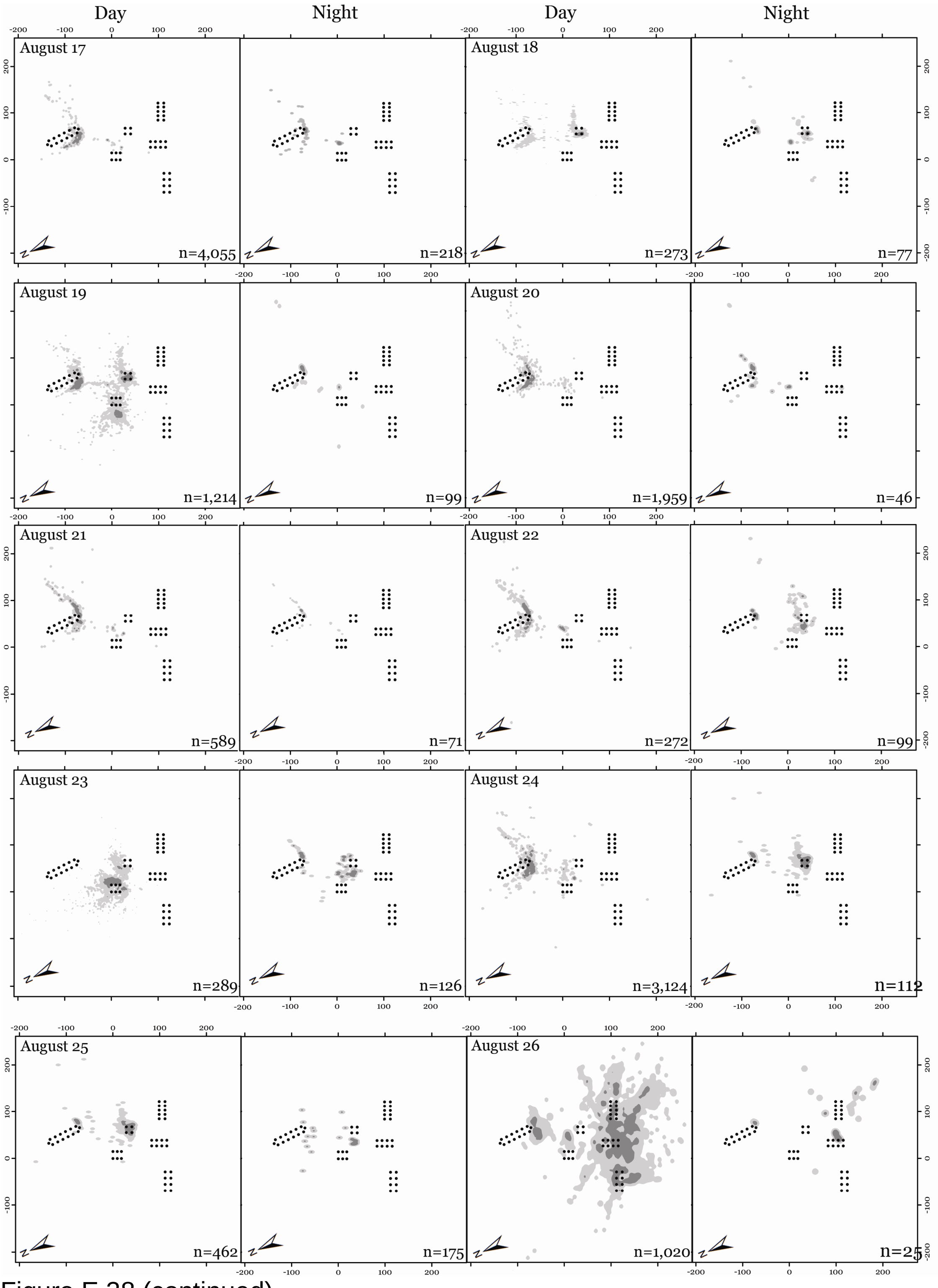


Figure E.38. The day and night home range of tagged Fish 33800 over the period of August 9 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.



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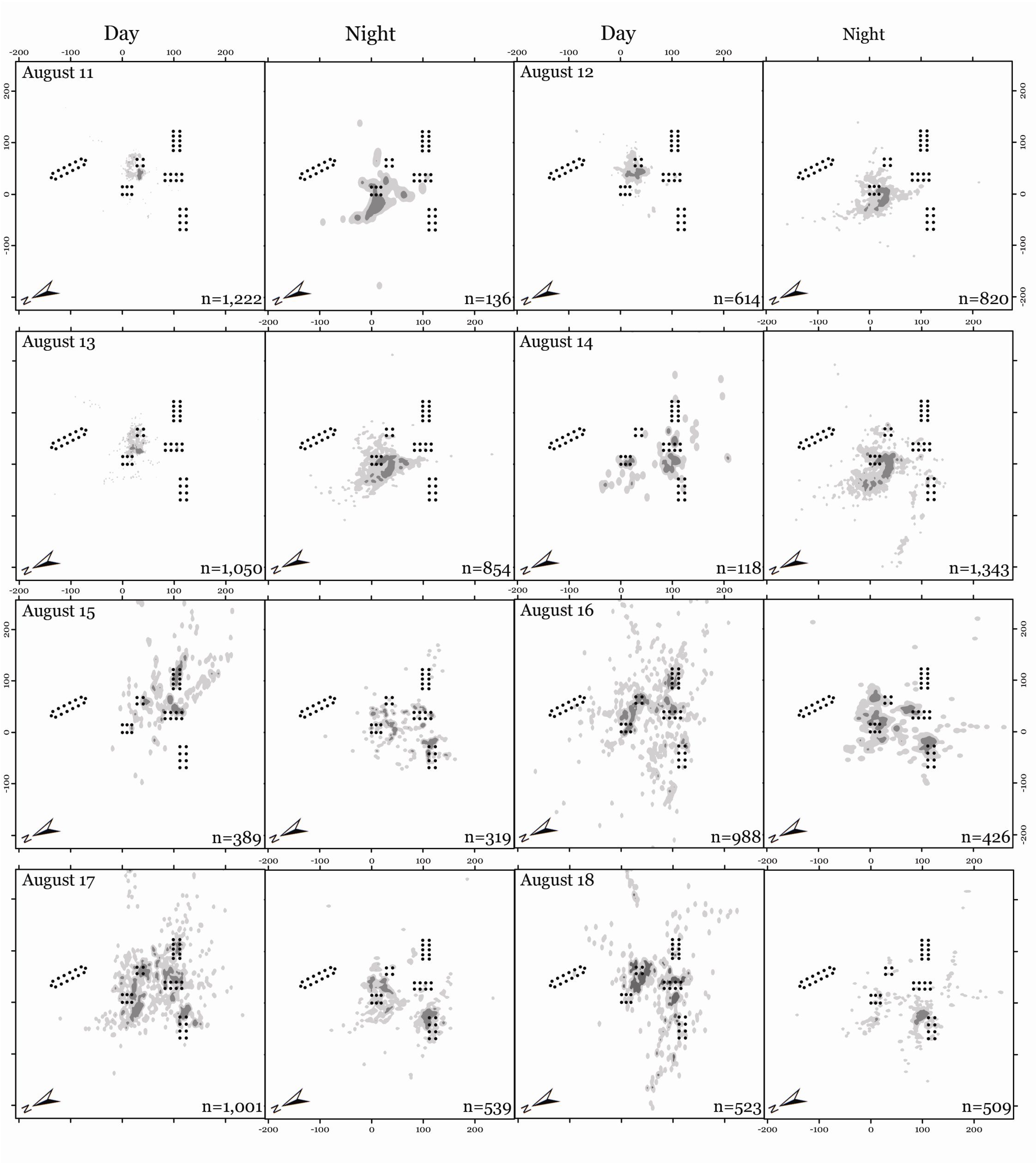


Figure E.39. The day and night home range of tagged Fish 34000 over the period of August 11 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

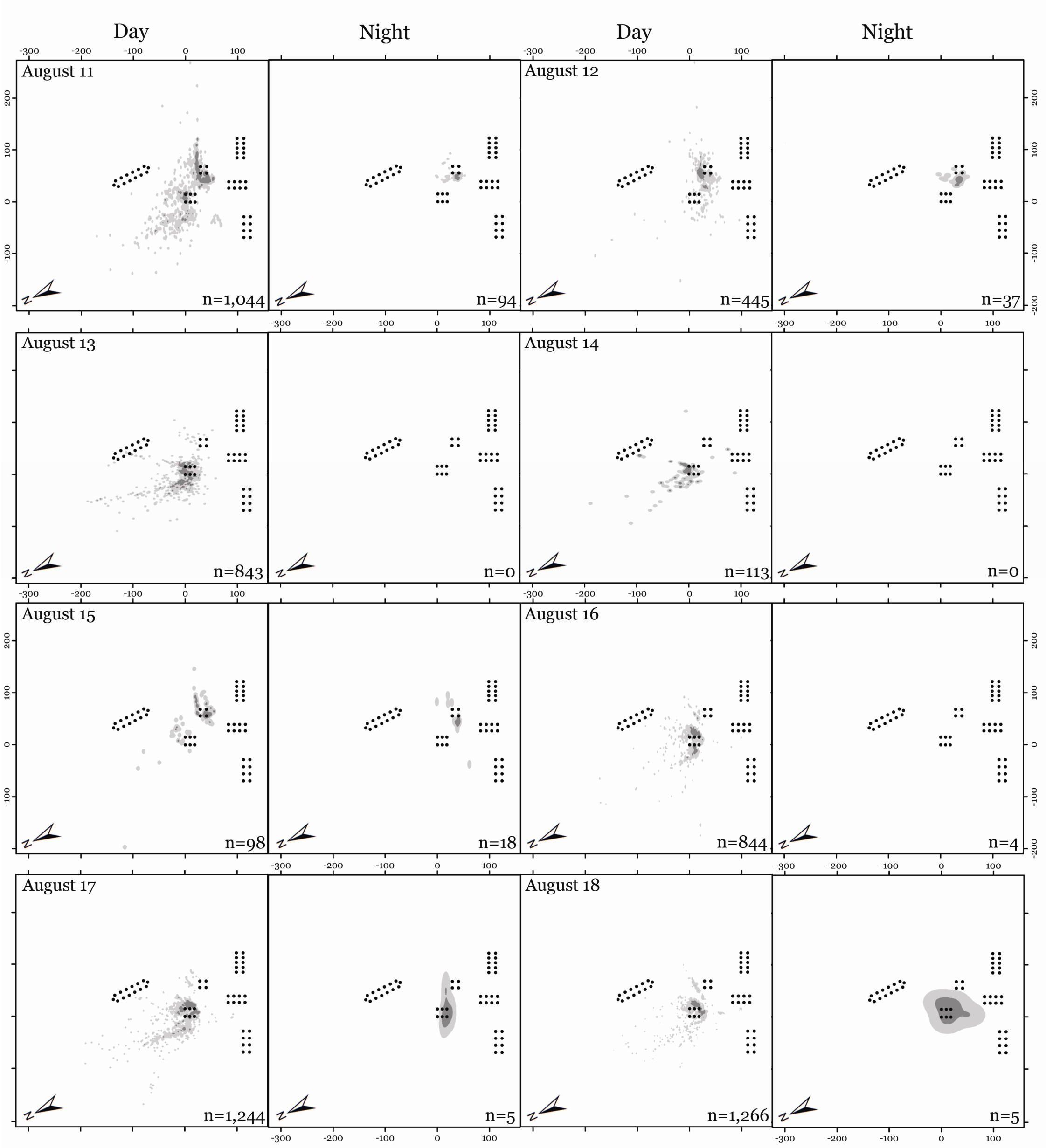
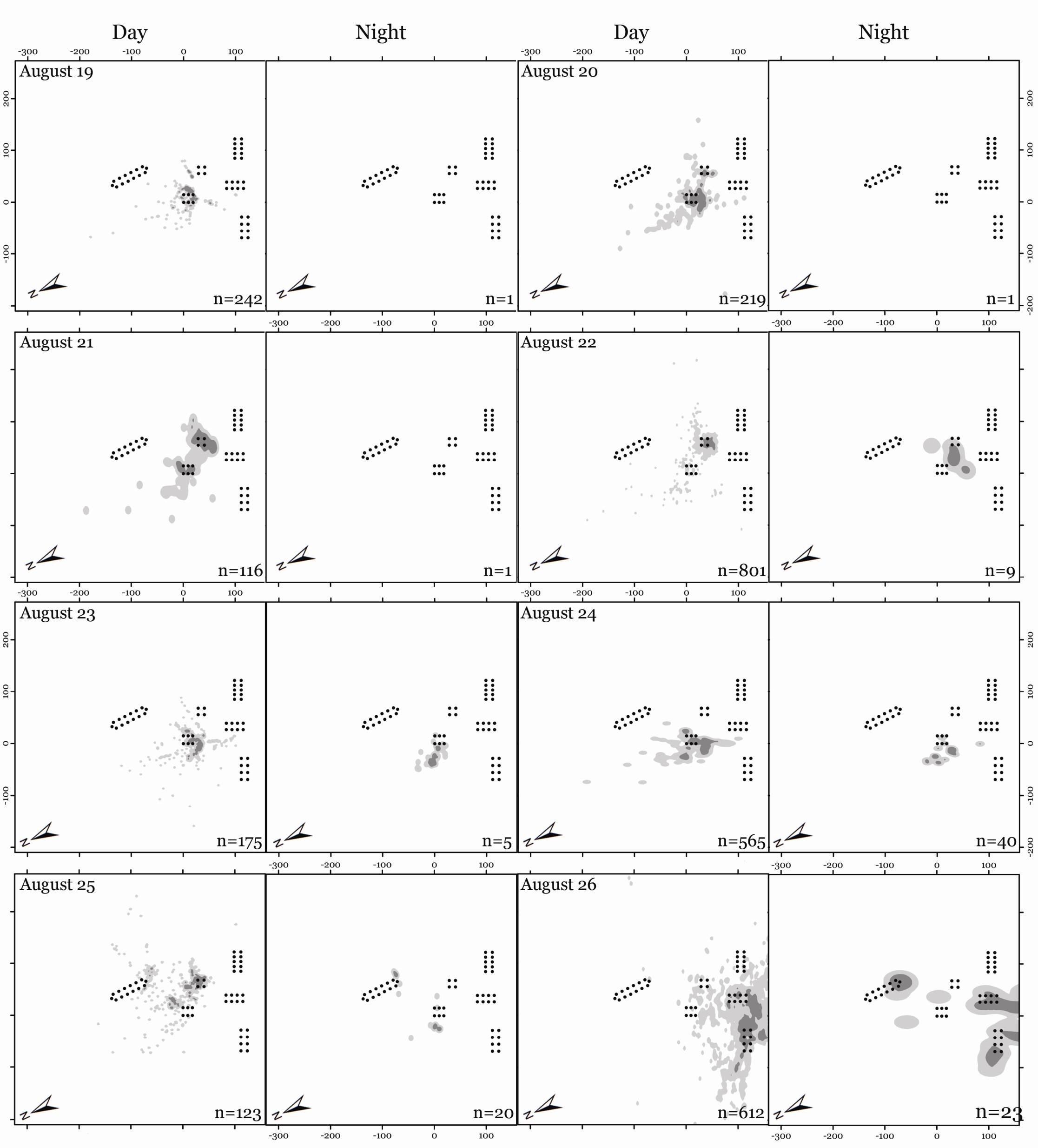


Figure E.40. The day and night home range of tagged Fish 34200 over the period of August 11 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish



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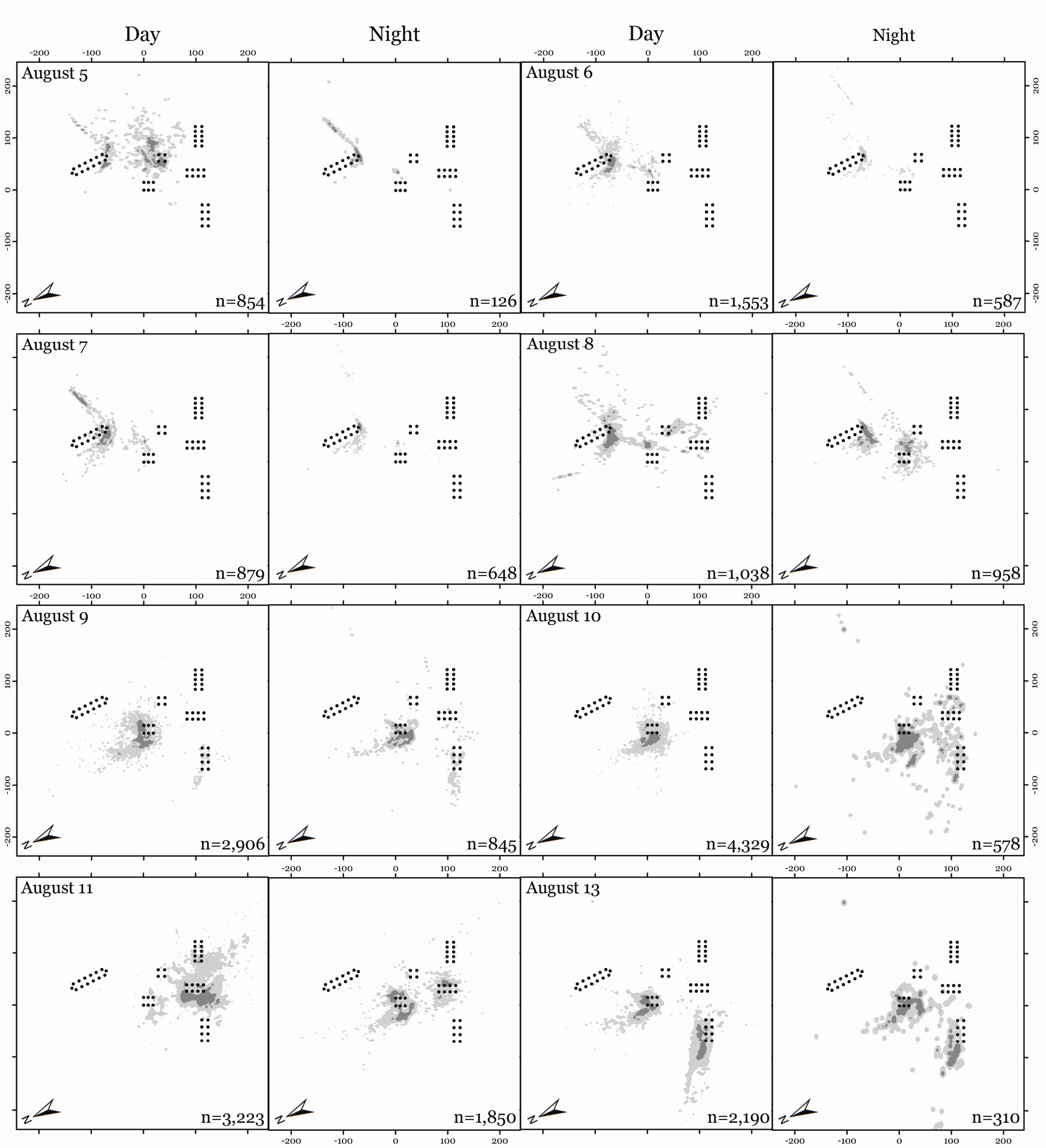
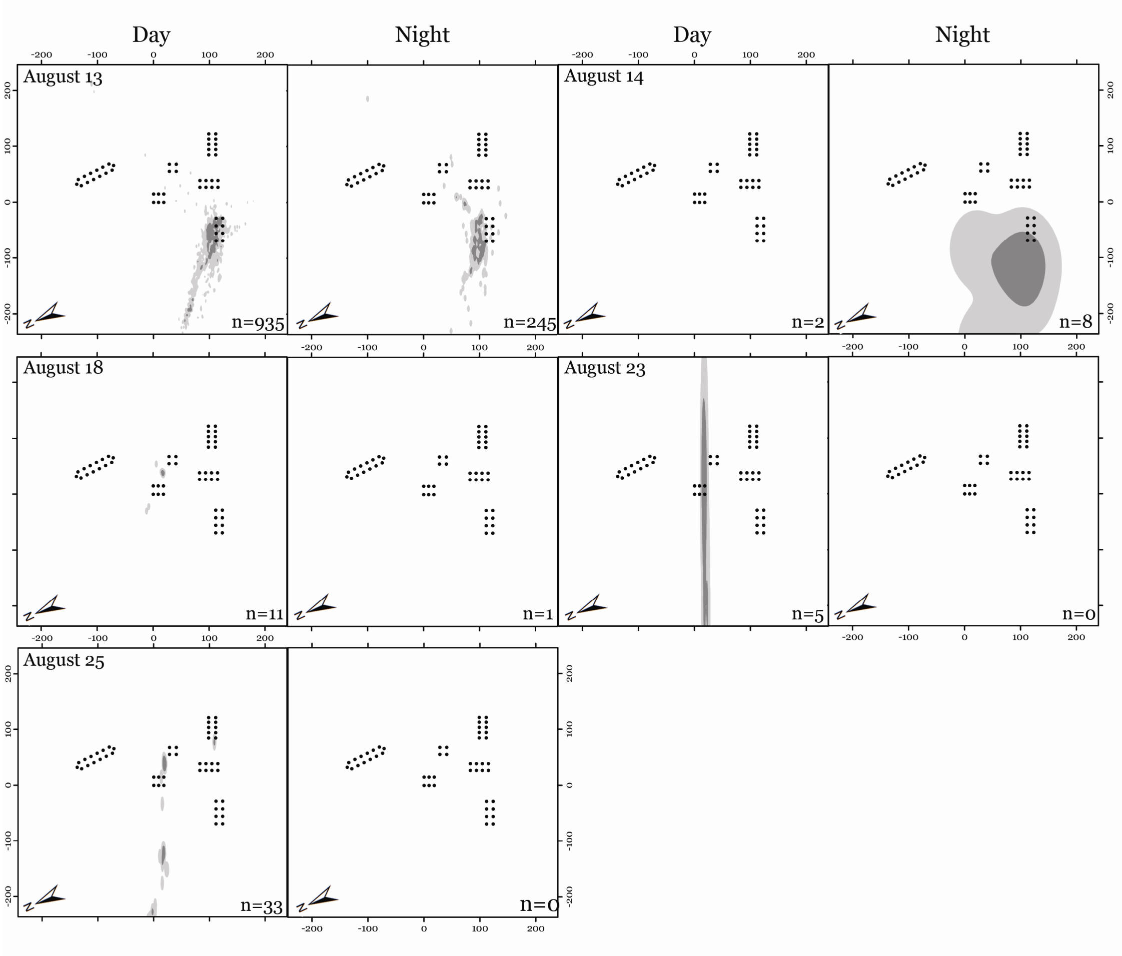


Figure E.41. The day and night home range of tagged Fish 34300 over the period of August 5 - 25, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish. August 15 (n=0), August 16 (day n=1, night n=0), August 17 (day n=2, night n=0), August 19 (day n=2, night n=0), August 20 (day n=3, night n=0), August 21 (day n=3, night n=0), and August 22 (day n=3, night n=0), August 24 (day n=4, night n=0) are not shown due to lack of localizations during those time periods.



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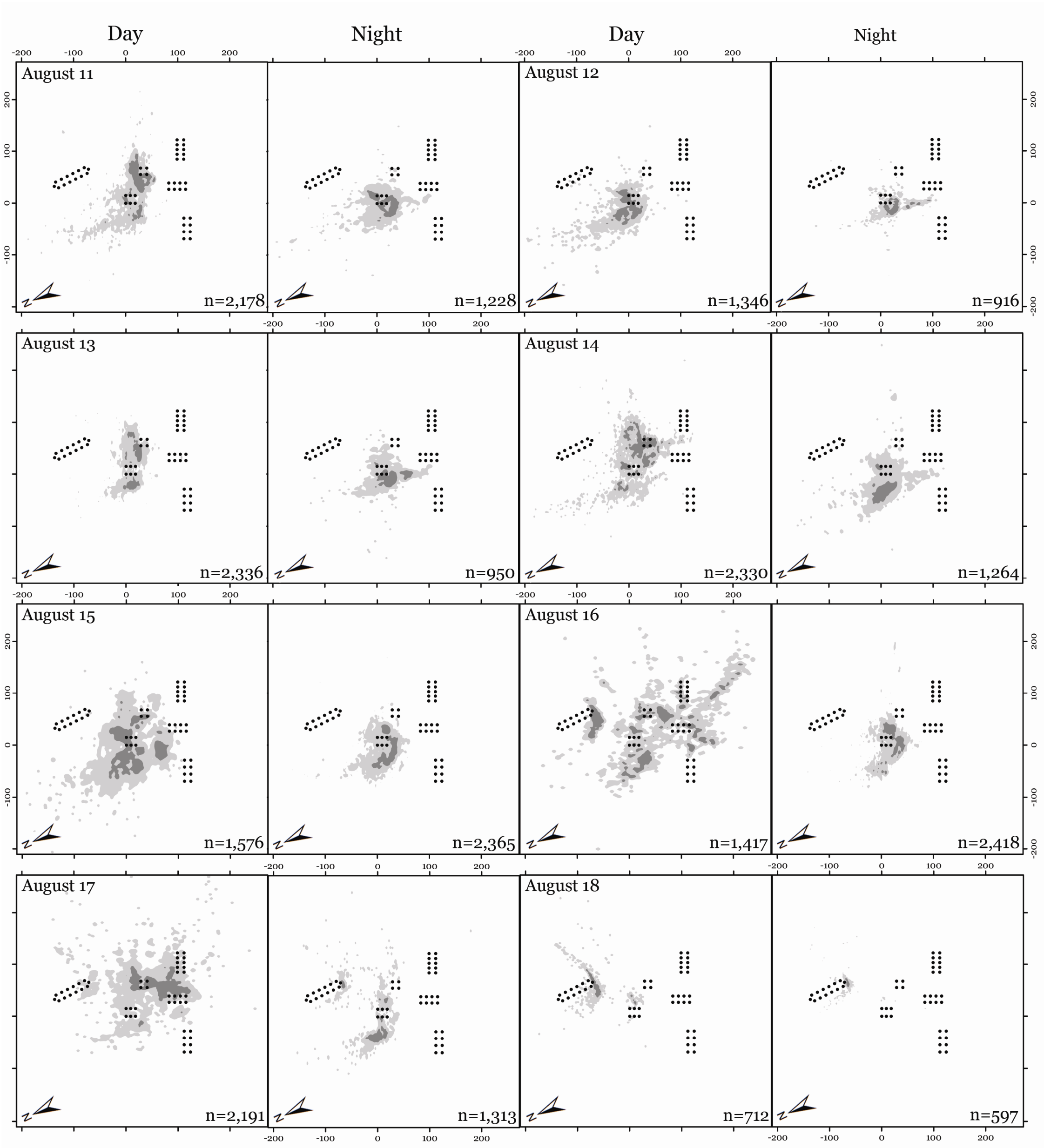
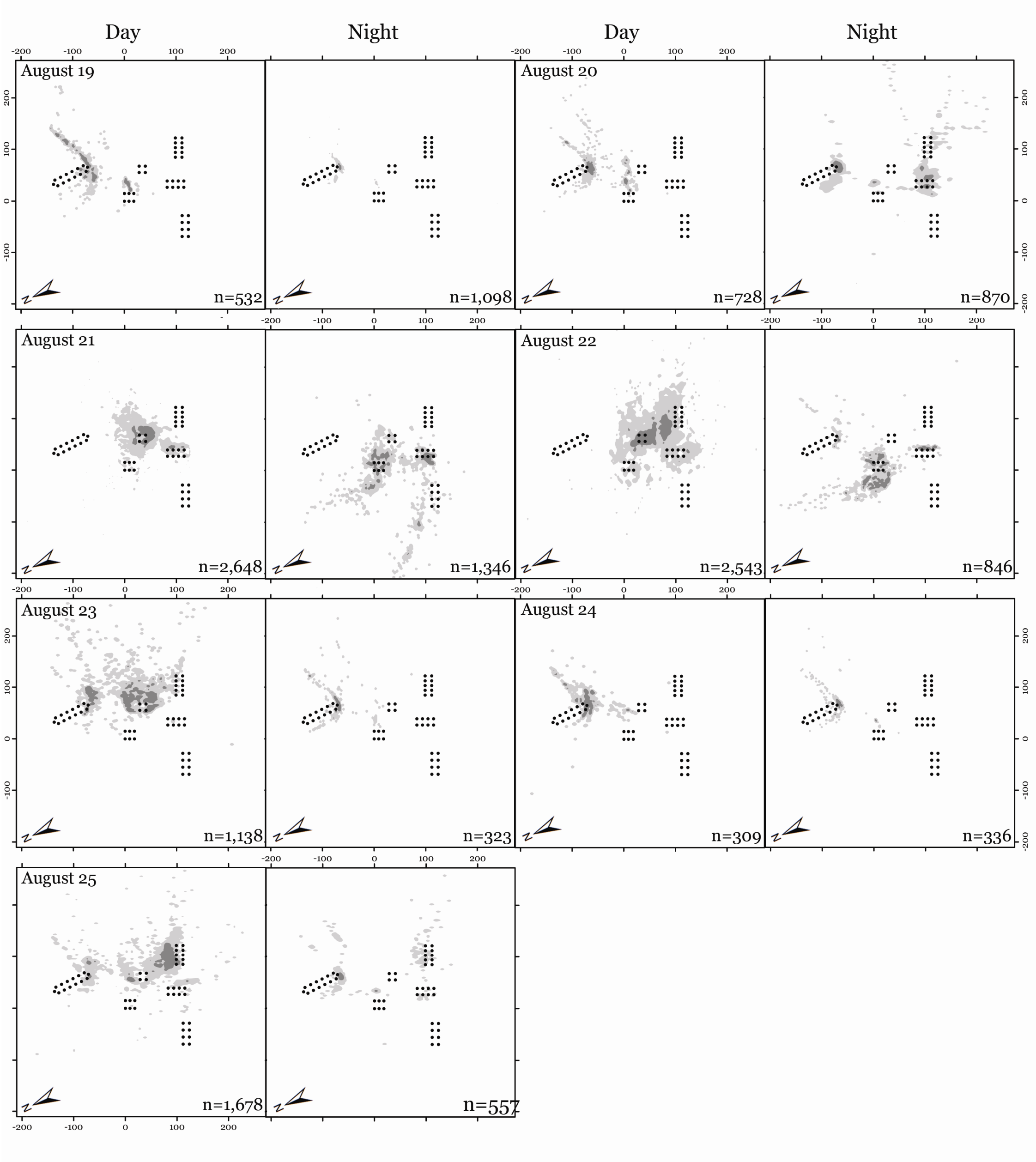


Figure E.42. The day and night home range of tagged Fish 34600 over the period of August 11 - 25, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.



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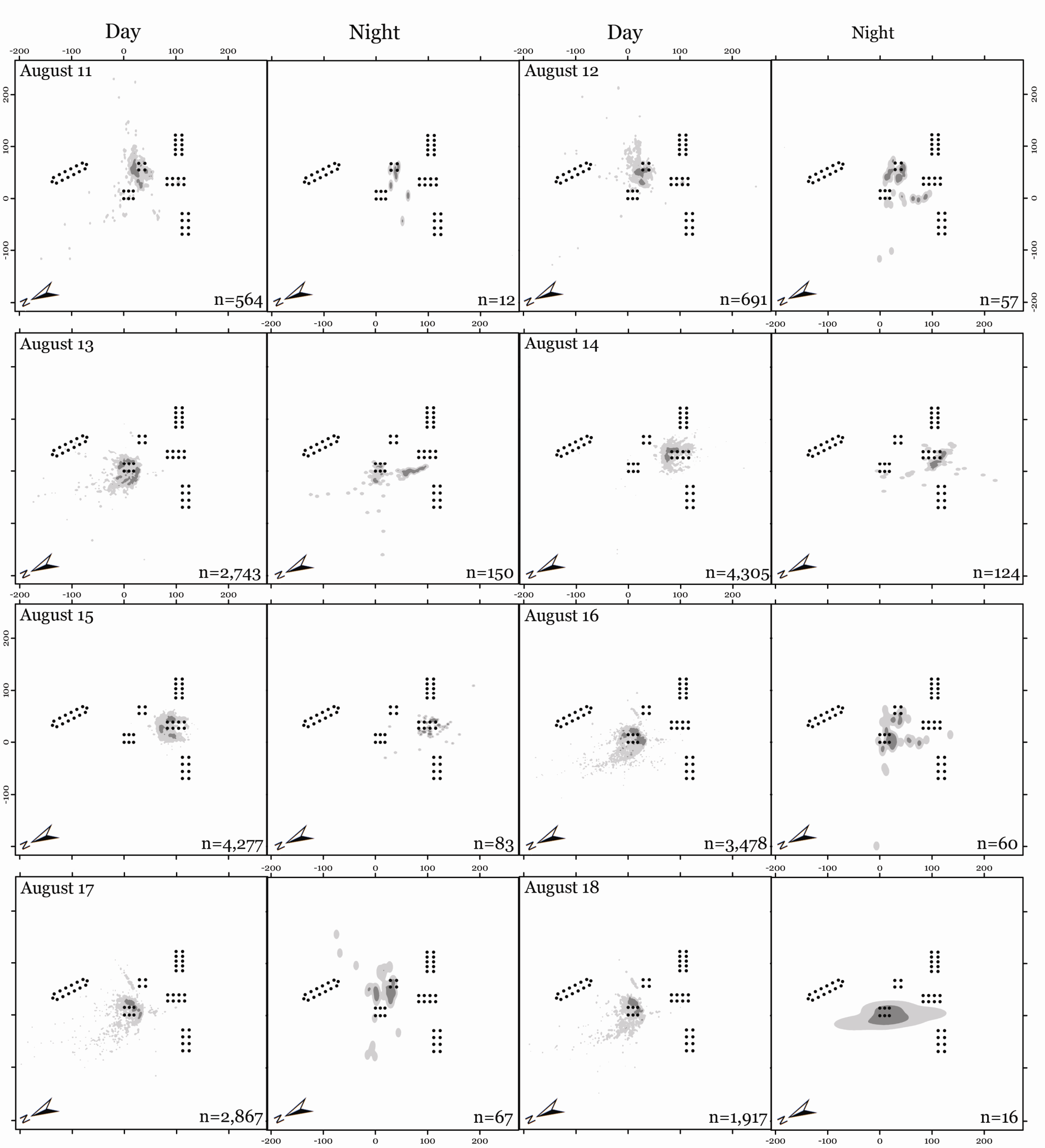
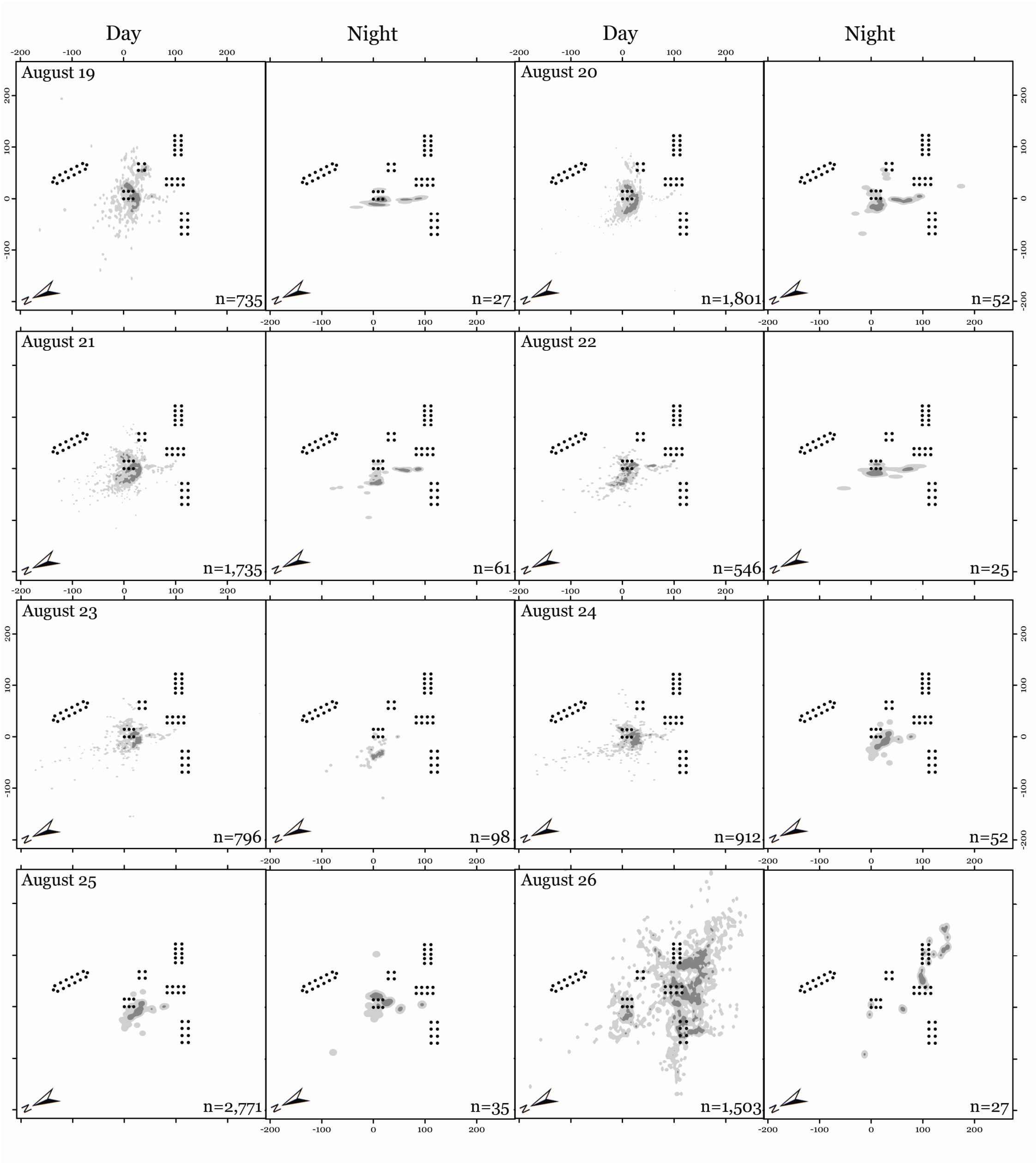


Figure E.43. The day and night home range of tagged Fish 34800 over the period of August 10 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.



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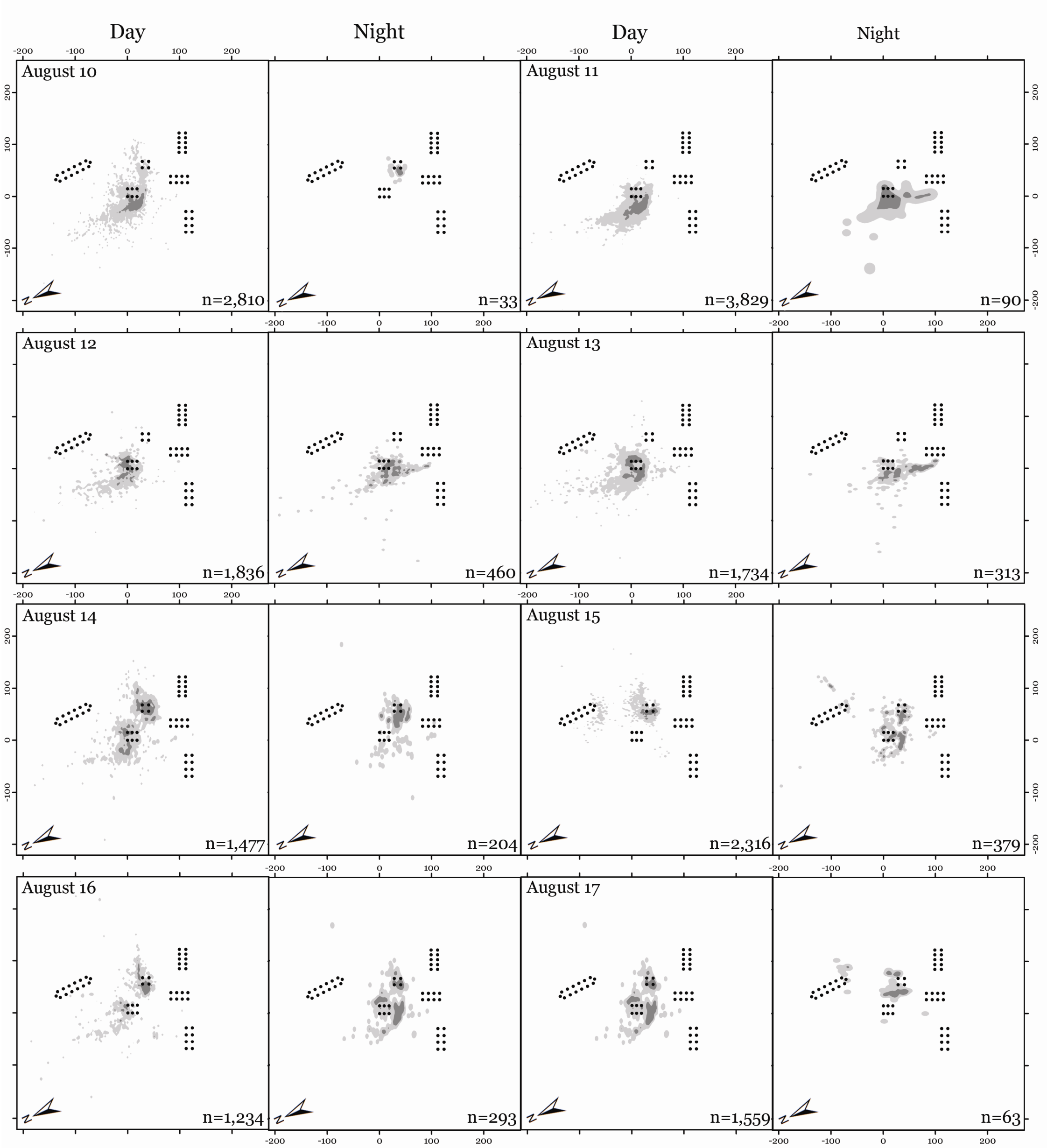
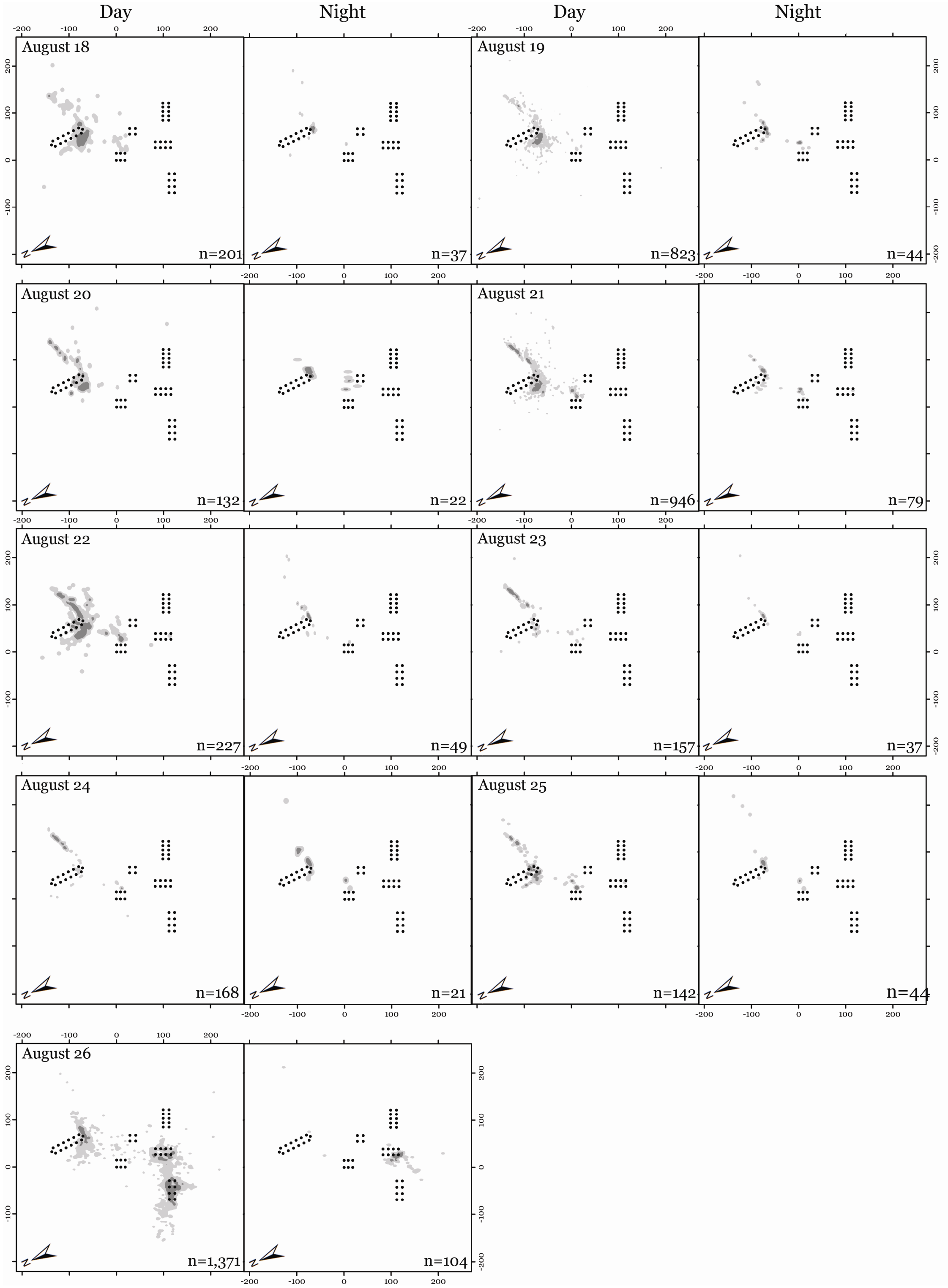


Figure E.44. The day and night home range of tagged Fish 34900 over the period of August 10 - 26, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.



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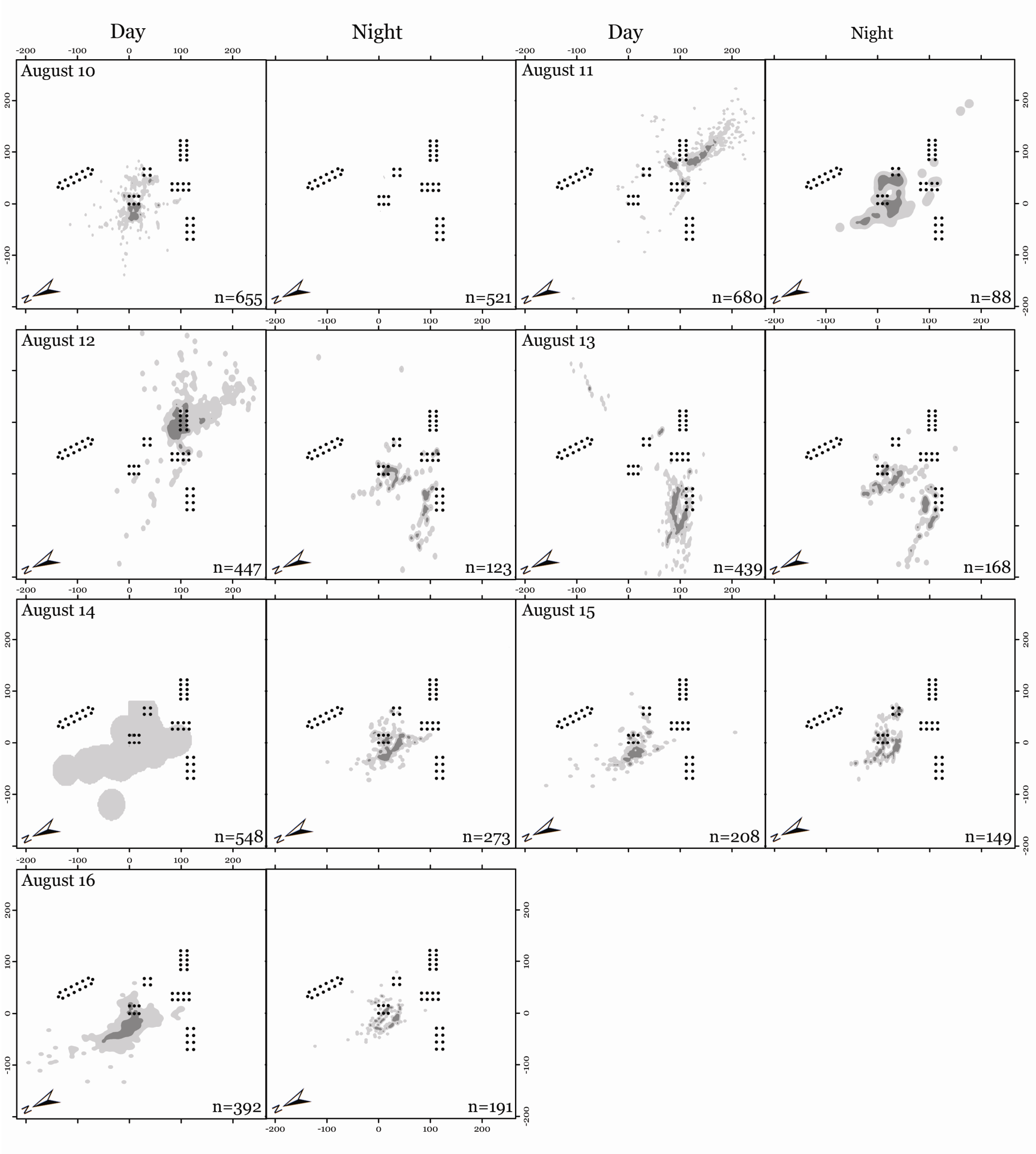

Figure E.45. The day and night home range of tagged Fish 35000 over the period of August 10 - 16, 2005. The dots indicate the legs of the six petroleum platforms at ST151. The dark gray areas indicate the core range of the fish. The light gray areas indicate the extent of the 95% range of the fish.

APPENDIX F: ADDITIONAL FIGURES FOR CHAPTER 3

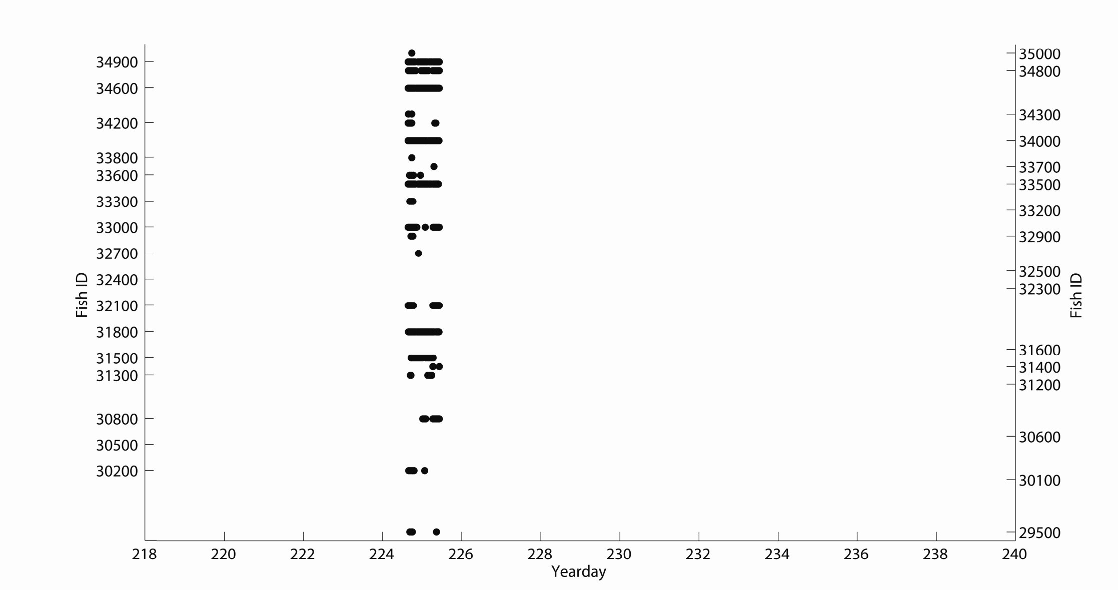

Figure F.1. The timing of all schooling events for Fish 30100 over the period August 12-13, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

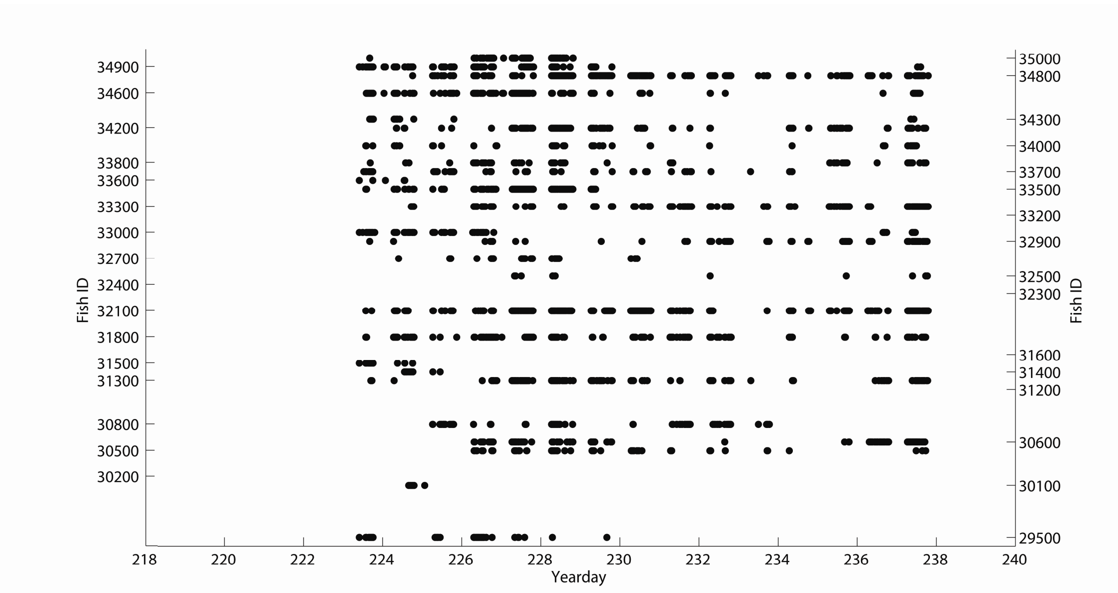

Figure F.2. The timing of all schooling events for Fish 30200 over the period August 10-25, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

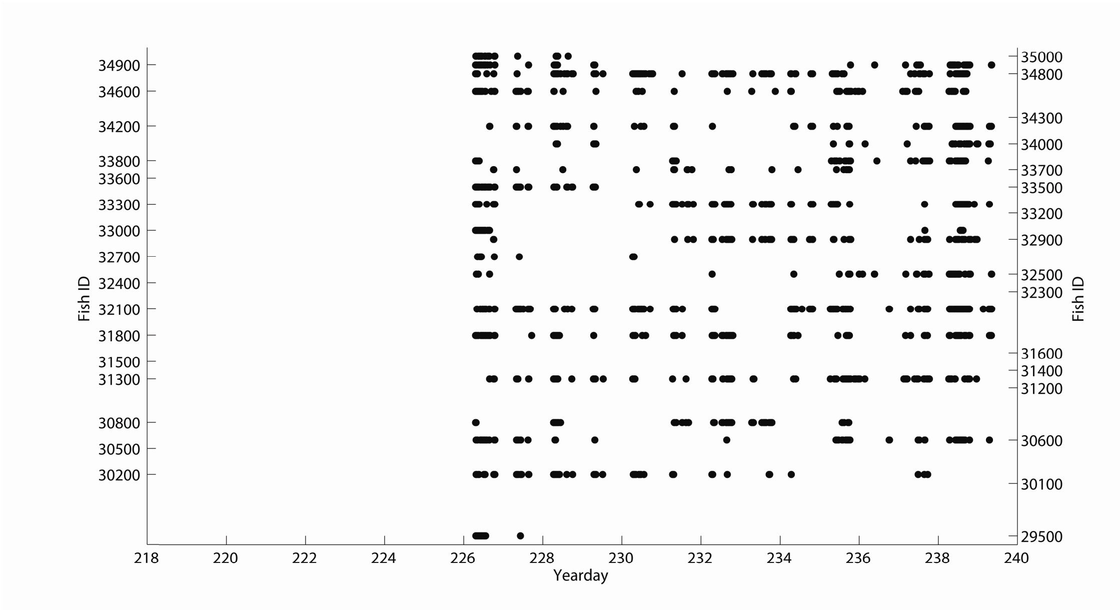

Figure F.3. The timing of all schooling events for Fish 30500 over the period August 13-27, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

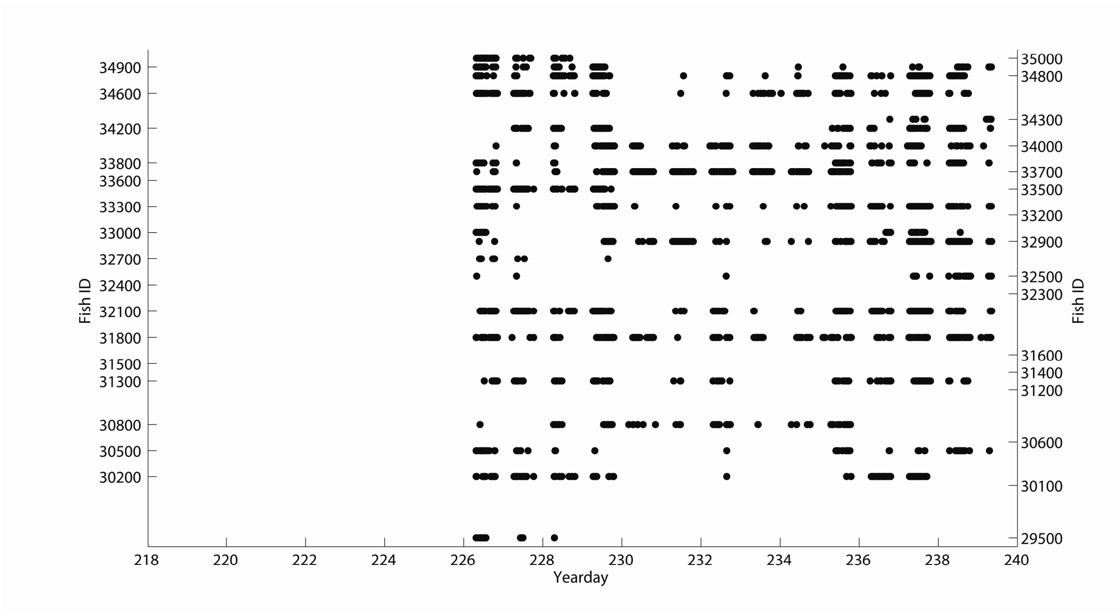

Figure F.4. The timing of all schooling events for Fish 30600 over the period August 13-27, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

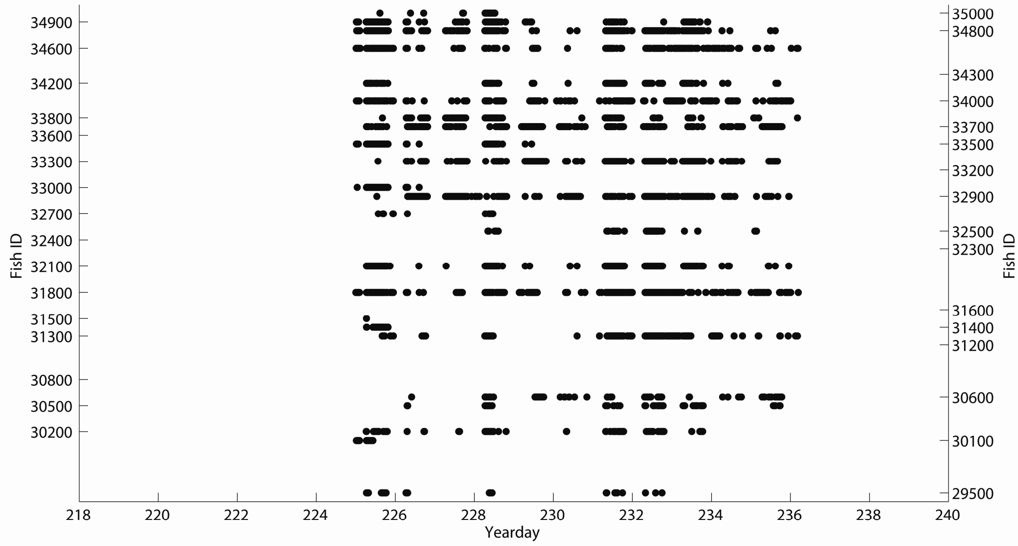

Figure F.5. The timing of all schooling events for Fish 30800 over the period August 12-25, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

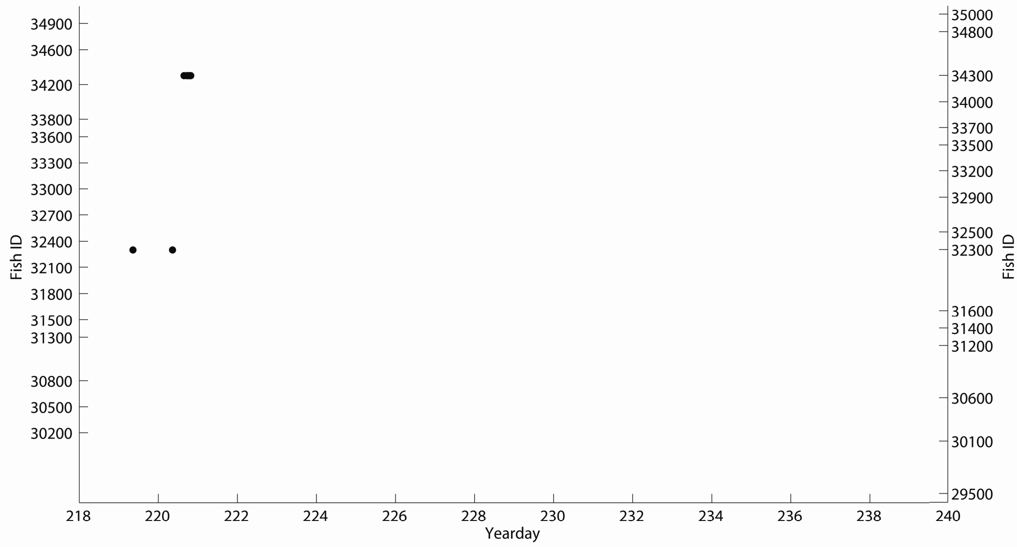

Figure F.6. The timing of all schooling events for Fish 31200 over the period August 7-8, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

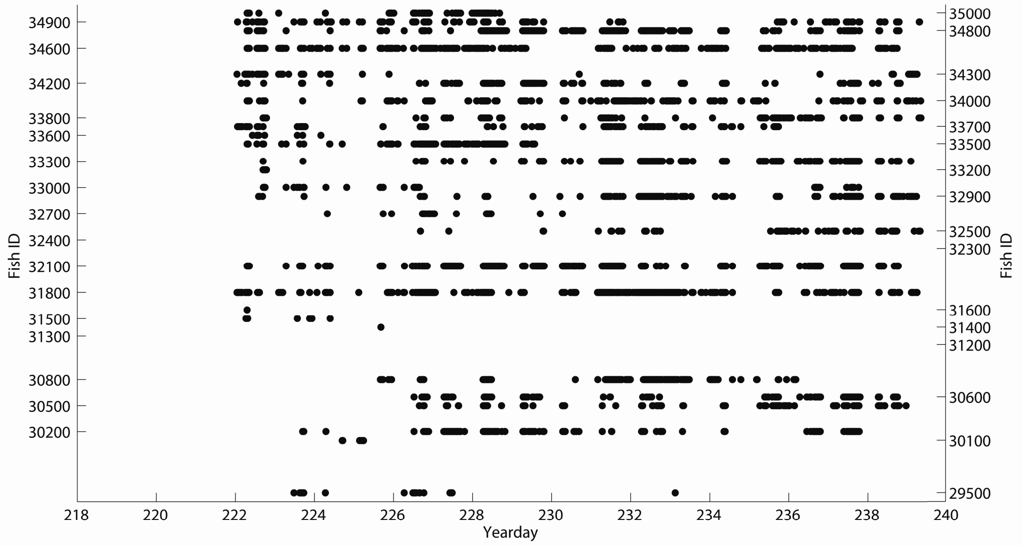

Figure F.7. The timing of all schooling events for Fish 31300 over the period August 8-25, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

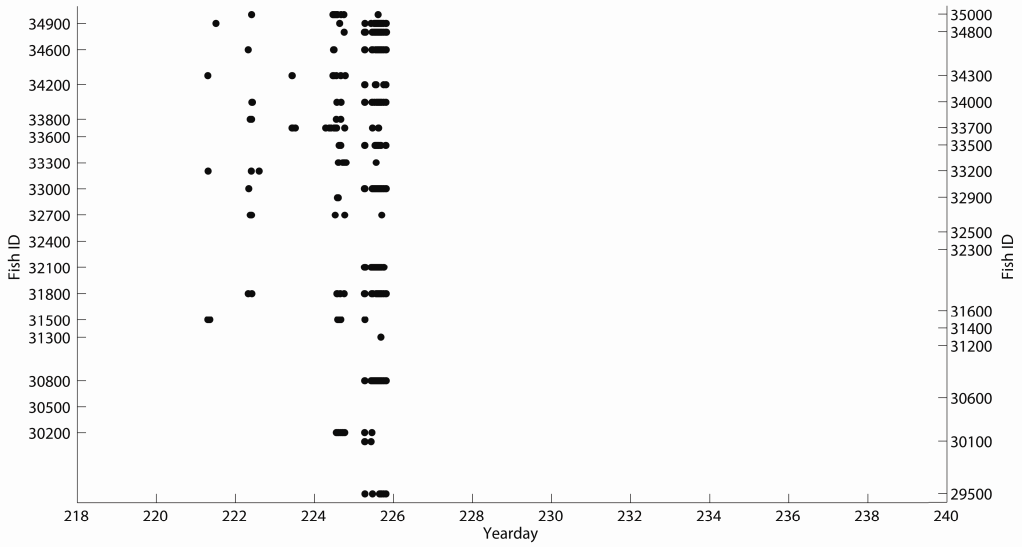

Figure F.8. The timing of all schooling events for Fish 31400 over the period August 9-13, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

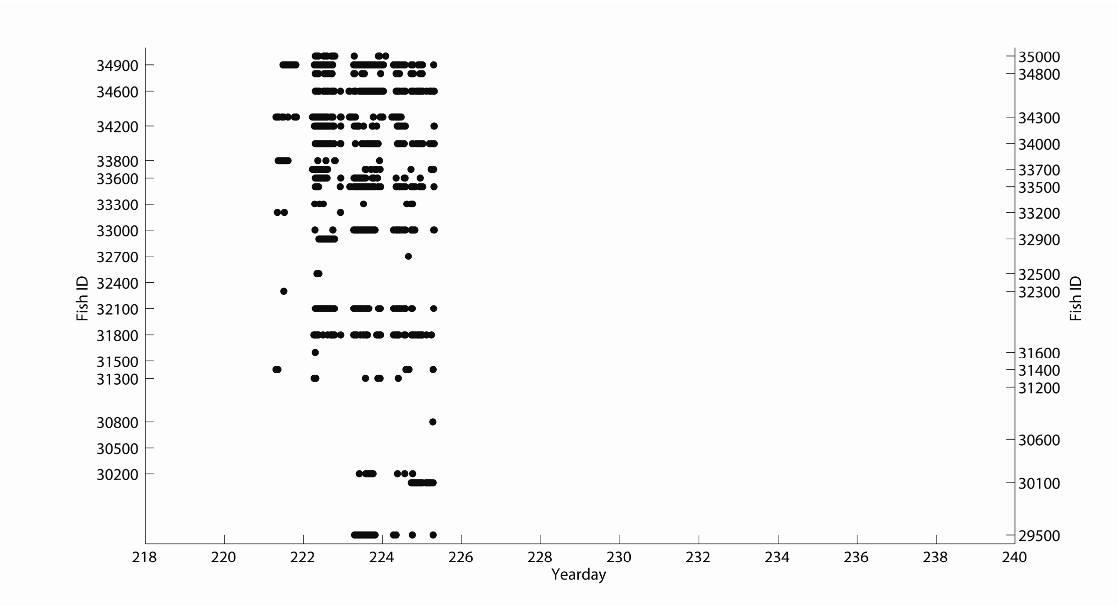

Figure F.9. The timing of all schooling events for Fish 31500 over the period August 9-13, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

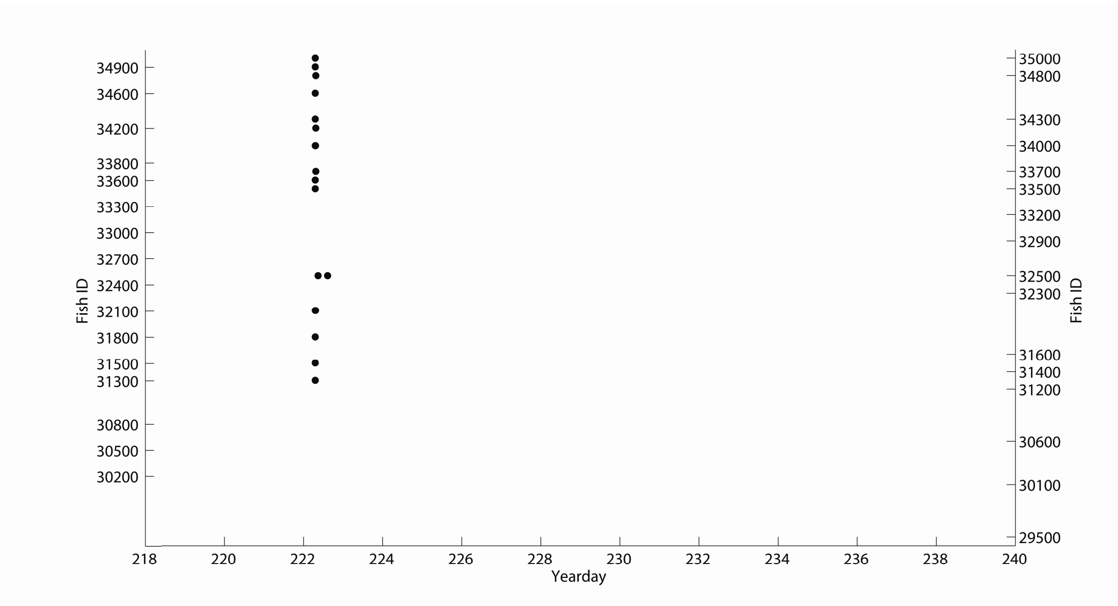

Figure F.10. The timing of all schooling events for Fish 31600 over the period August 10 & 12, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

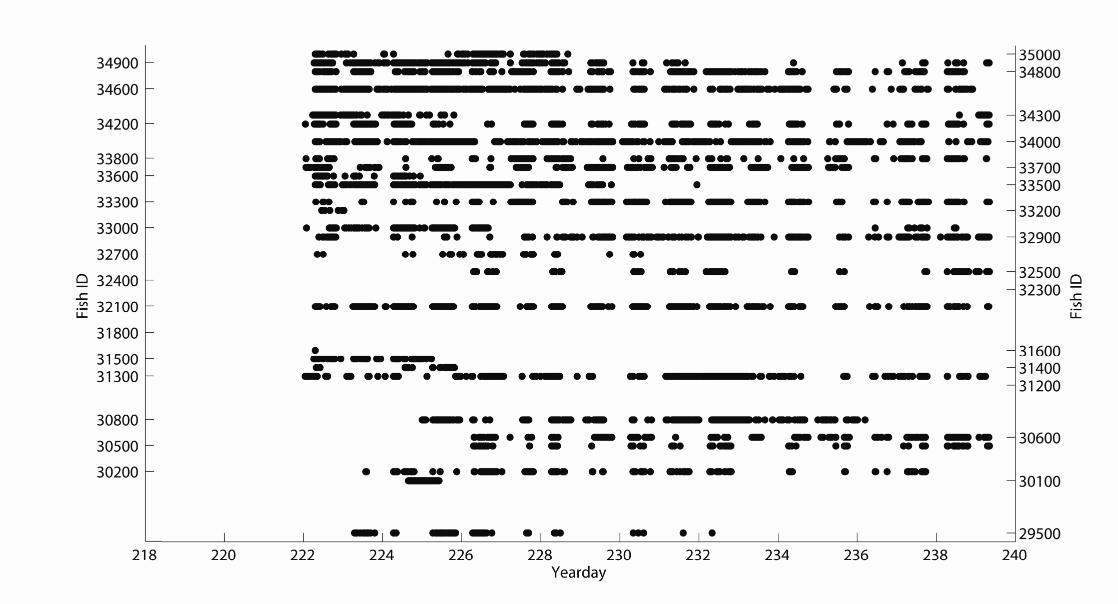

Figure F.11. The timing of all schooling events for Fish 31800 over the period August 8-25, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

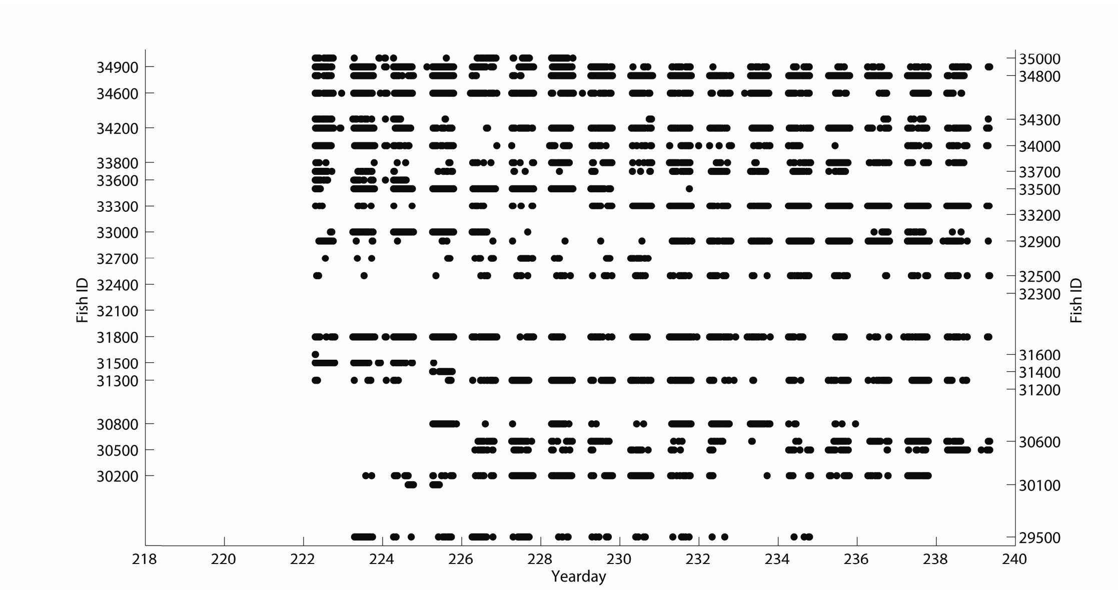

Figure F.12. The timing of all schooling events for Fish 32100 over the period August 9-26, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

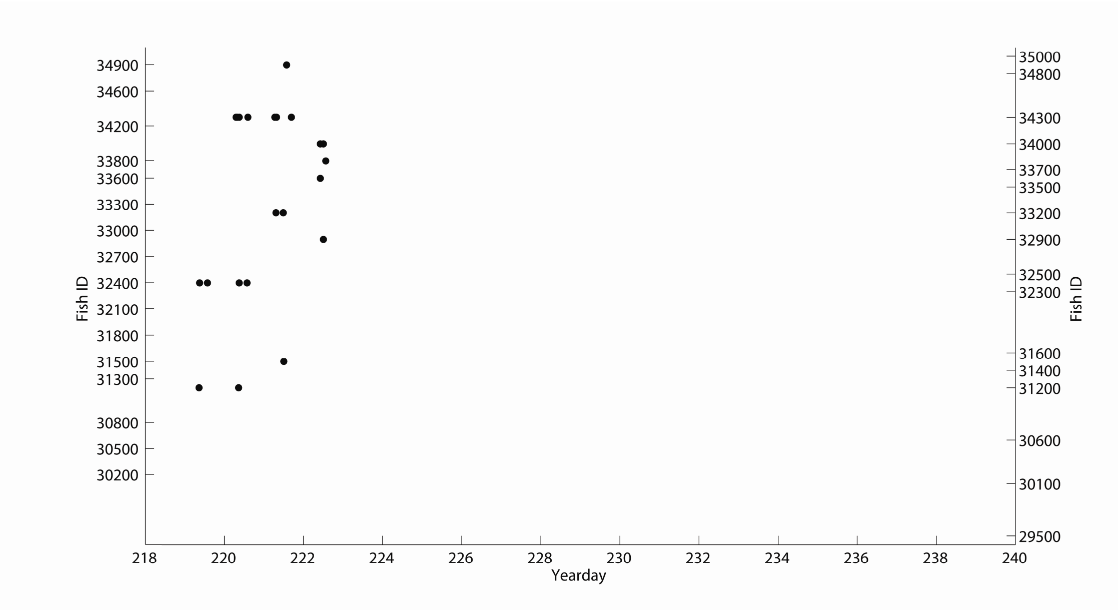

Figure F.13. The timing of all schooling events for Fish 32300 over the period August 7-10, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

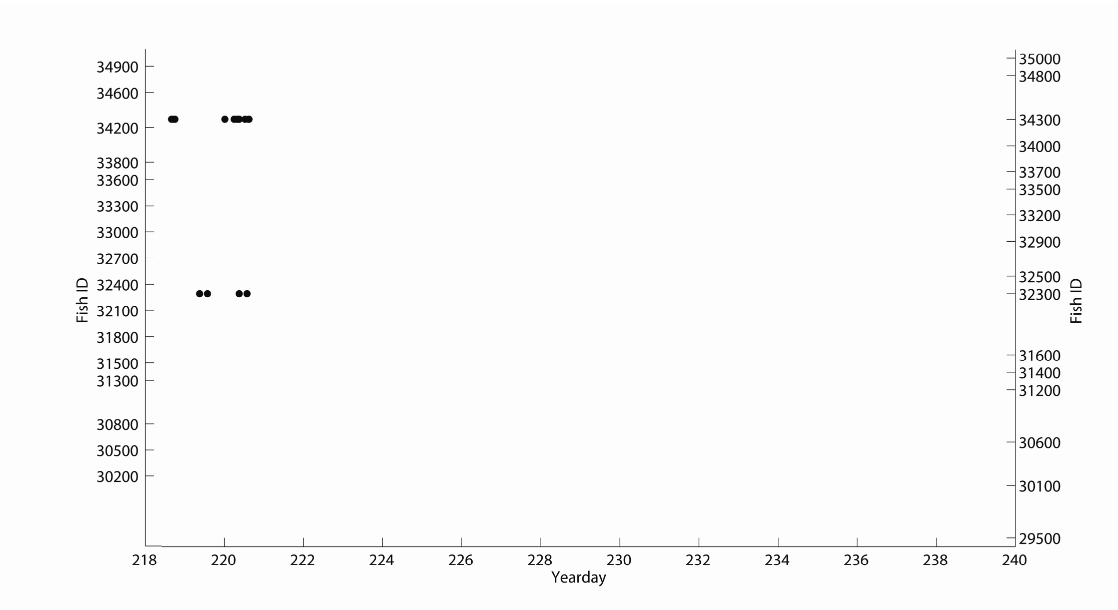

Figure F.14. The timing of all schooling events for Fish 32400 over the period August 6-8, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

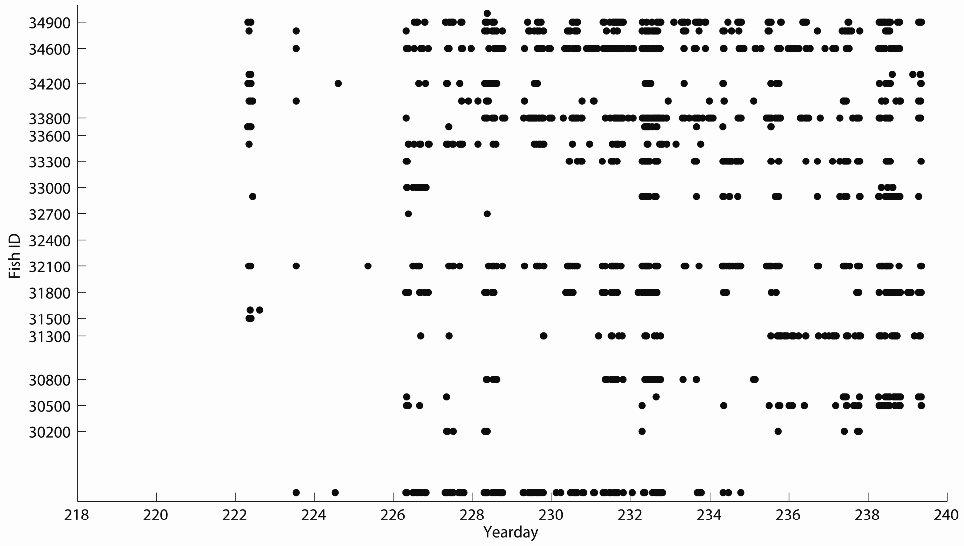

Figure F.15. The timing of all schooling events for Fish 32500 over the period August 8-27, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

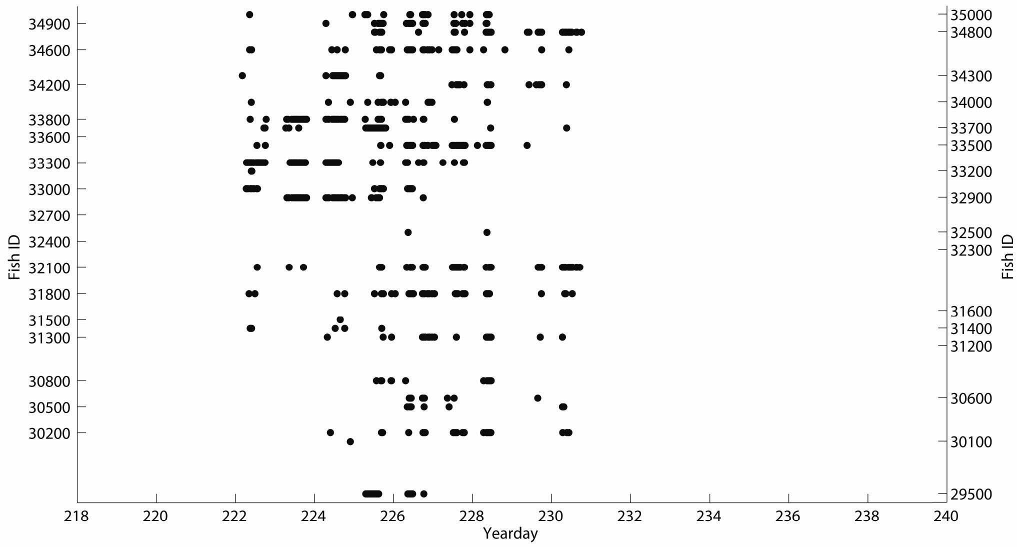

Figure F.16. The timing of all schooling events for Fish 32700 over the period August 8-19, 2005. Each circle indicates one localization where the two fish were 50m or less from each other.

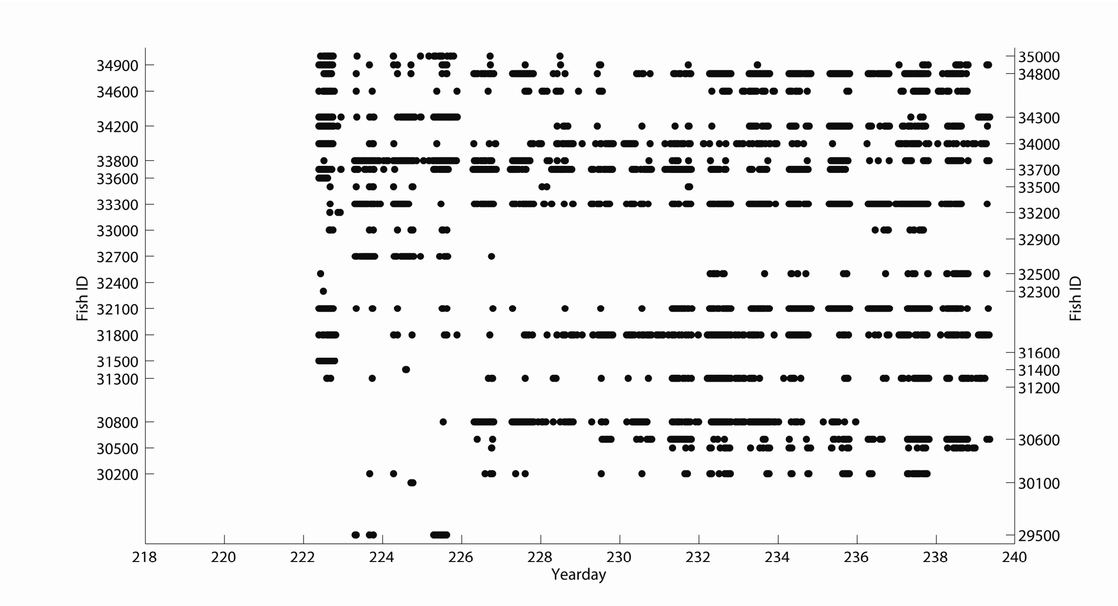

Figure F.17. The timing of all schooling events for Fish 32900 over the period August 10-27, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

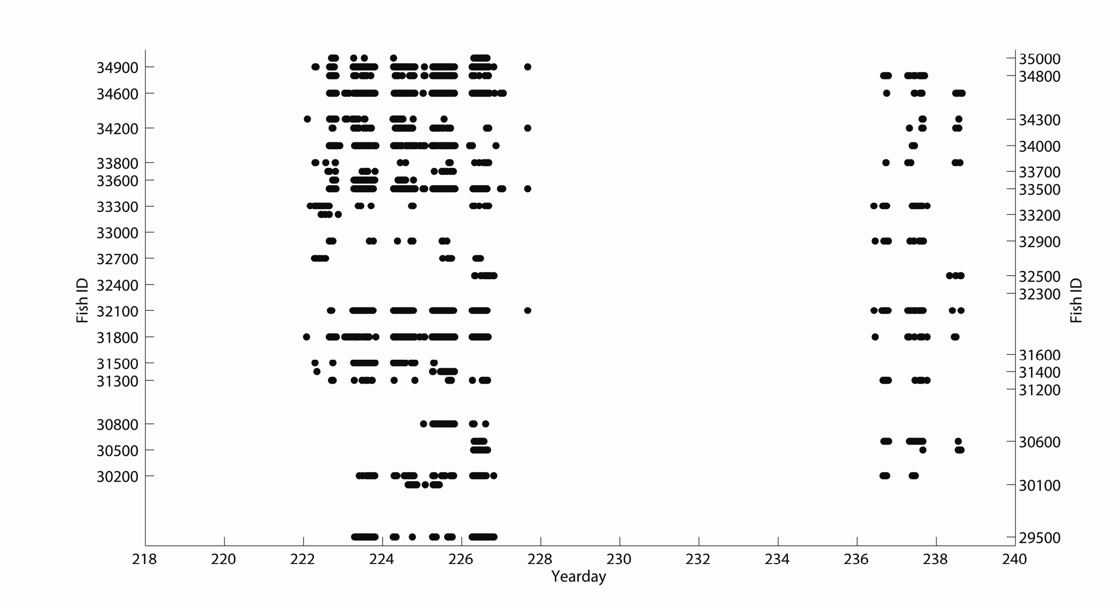

Figure F.18. The timing of all schooling events for Fish 33000 over the period August 8-26, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

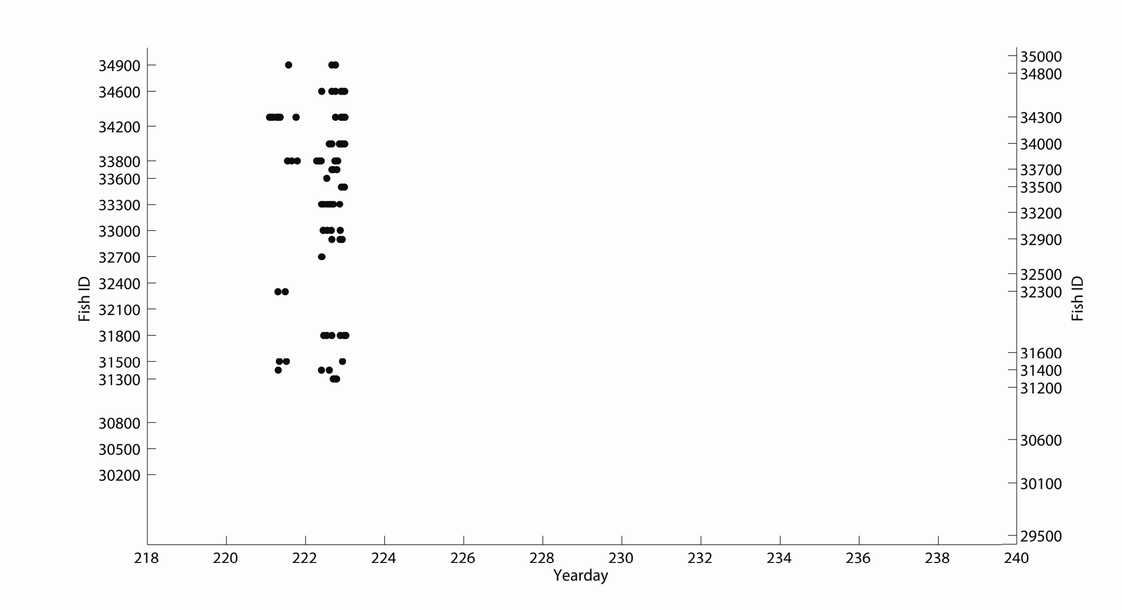

Figure F.19. The timing of all schooling events for Fish 33200 over the period August 8-11, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

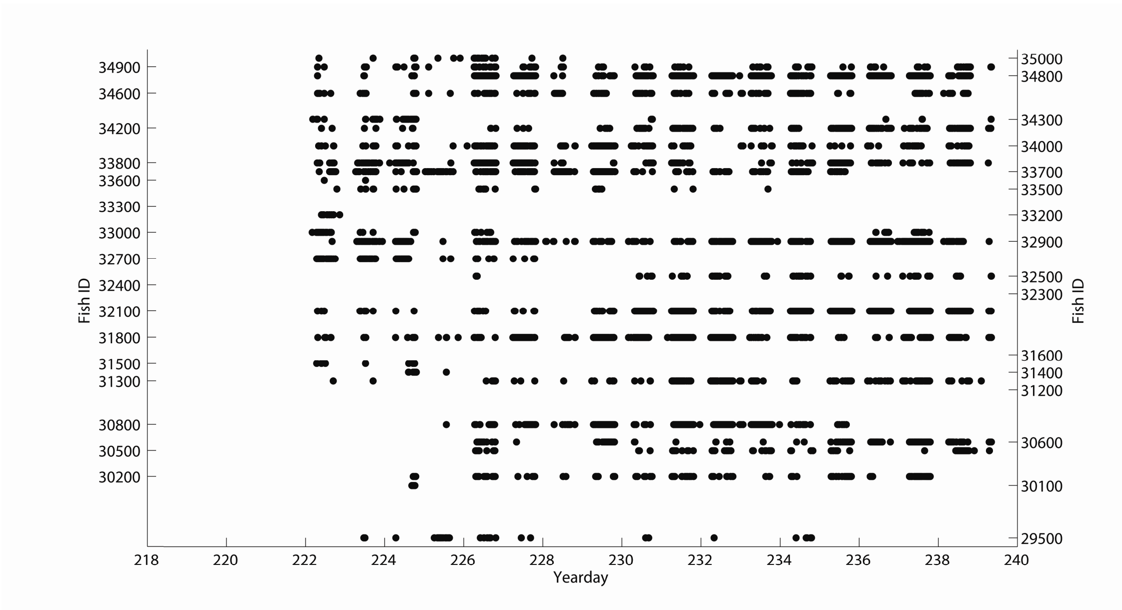

Figure F.20. The timing of all schooling events for Fish 33300 over the period August 8-27, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

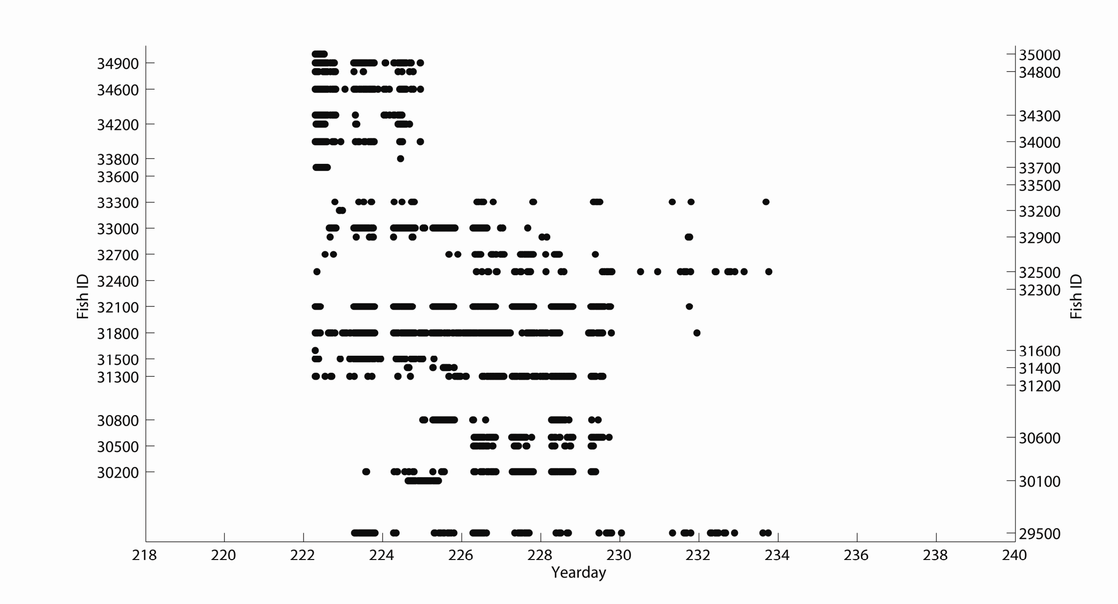

Figure F.21. The timing of all schooling events for Fish 33500 over the period August 9-25, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

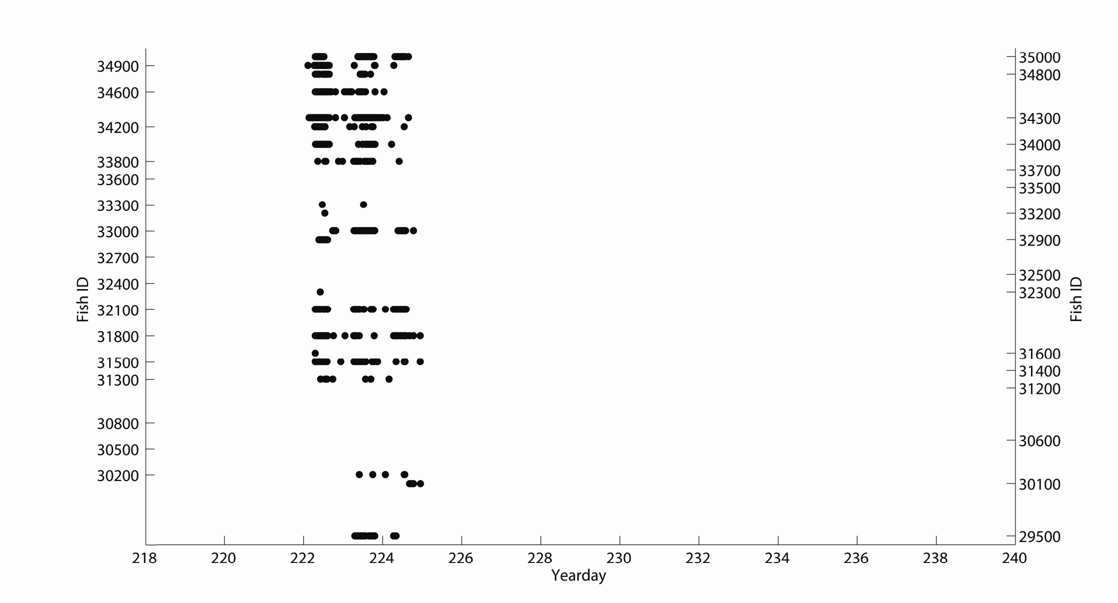

Figure F.22. The timing of all schooling events for Fish 33600 over the period August 10-12, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

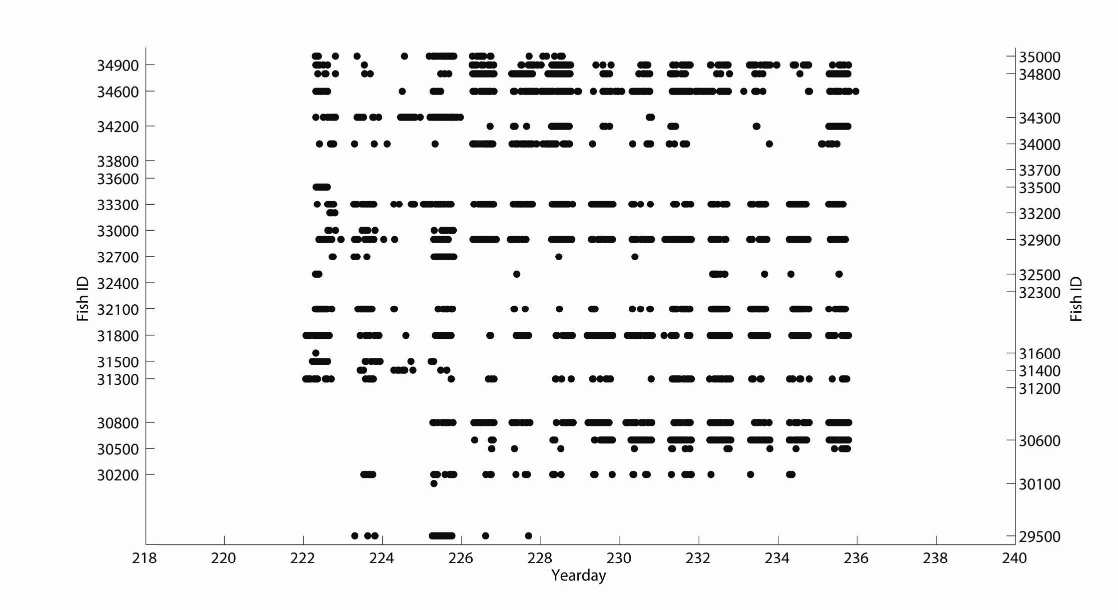

Figure F.23. The timing of all schooling events for Fish 33700 over the period August 8-25, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

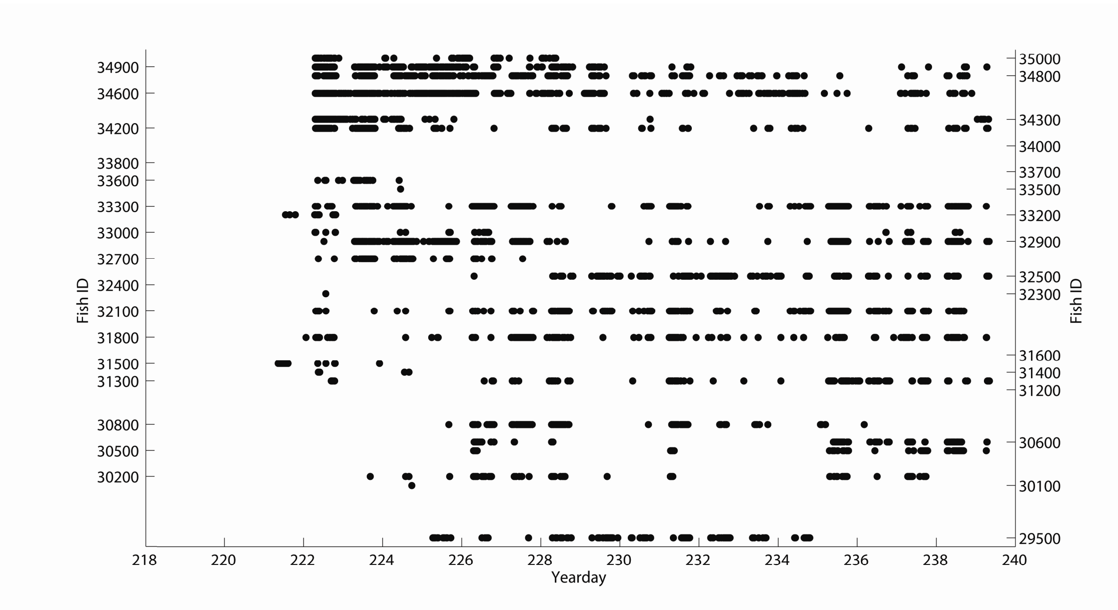

Figure F.24. The timing of all schooling events for Fish 33800 over the period August 8-25, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

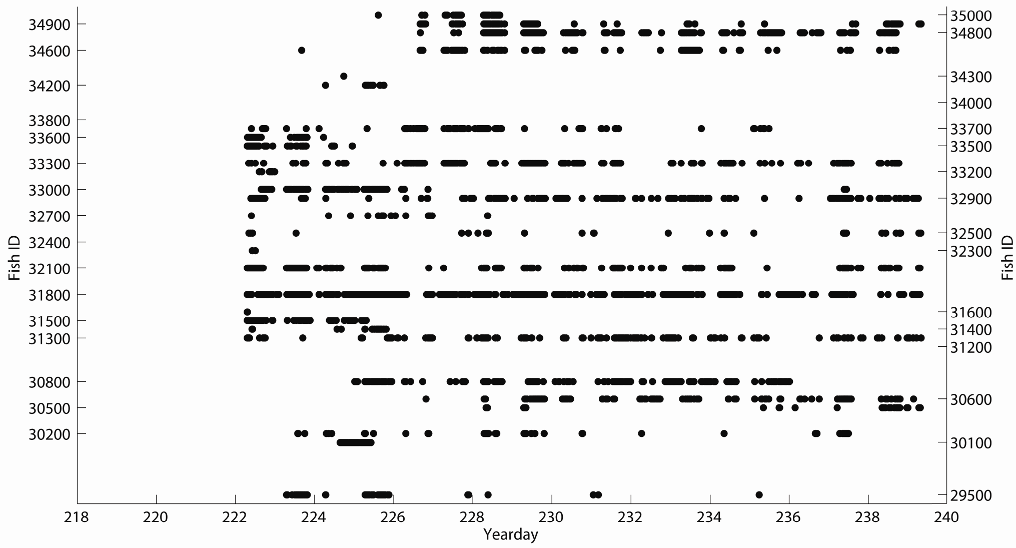

Figure F.25. The timing of all schooling events for Fish 34000 over the period August 9-27, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

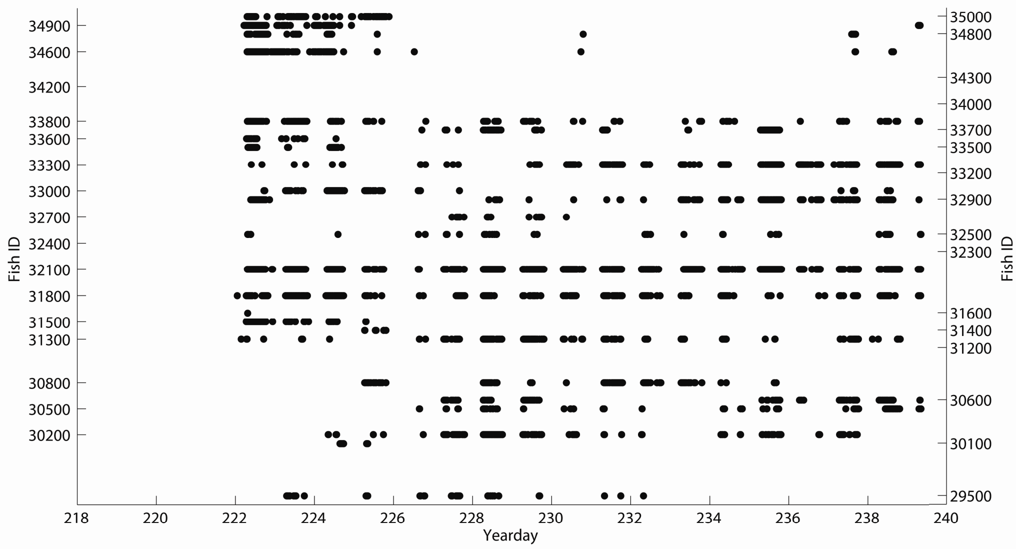

Figure F.26. The timing of all schooling events for Fish 34200 over the period August 8-25, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

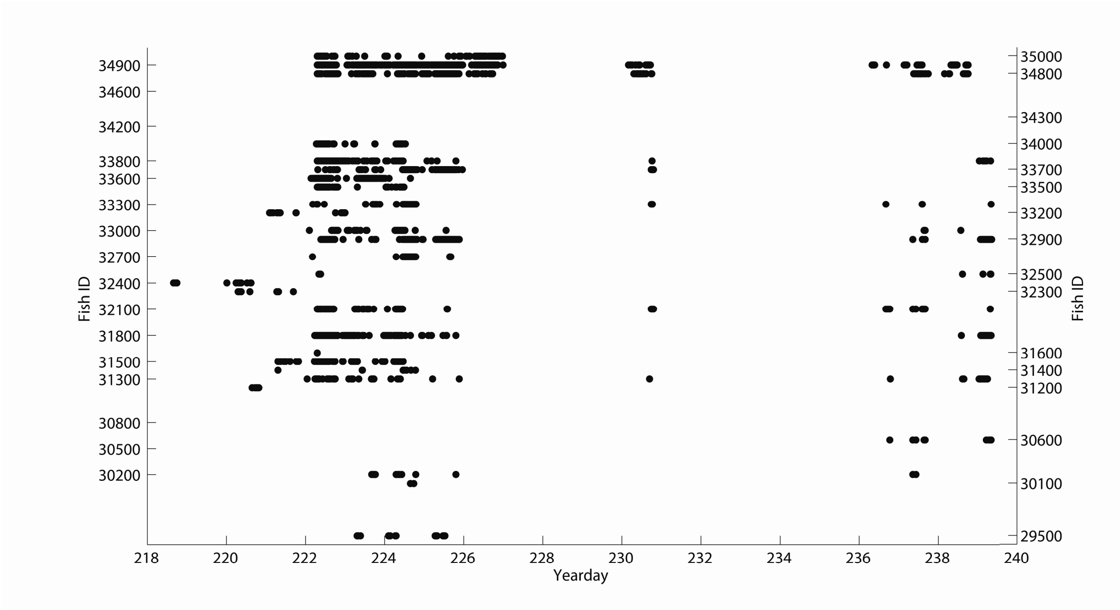

Figure F.27. The timing of all schooling events for Fish 34300 over the period August 6-27, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

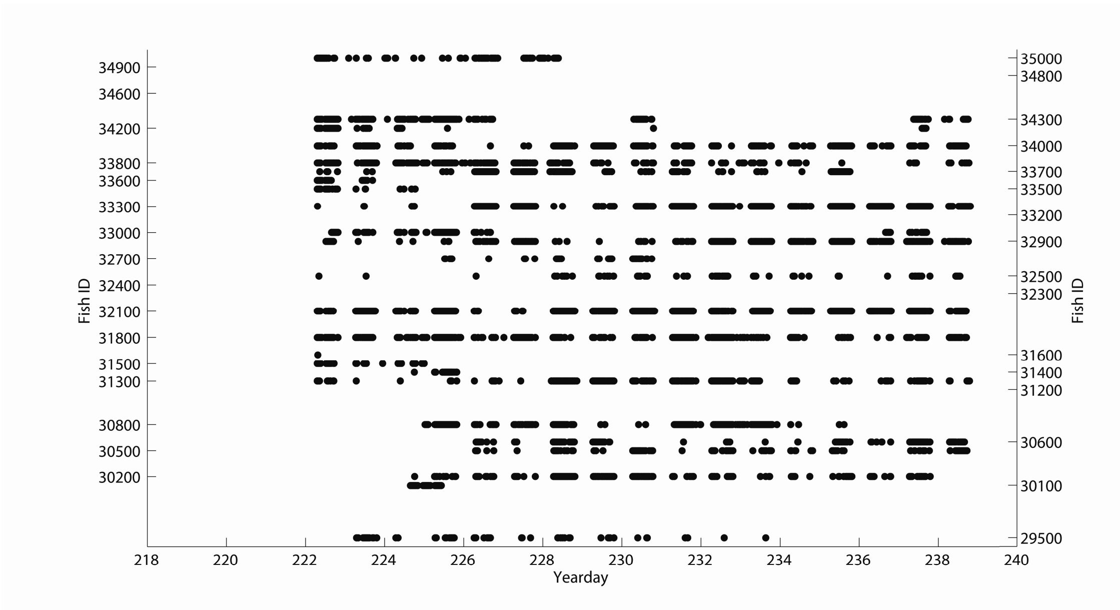

Figure F.28. The timing of all schooling events for Fish 34800 over the period August 9-26, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

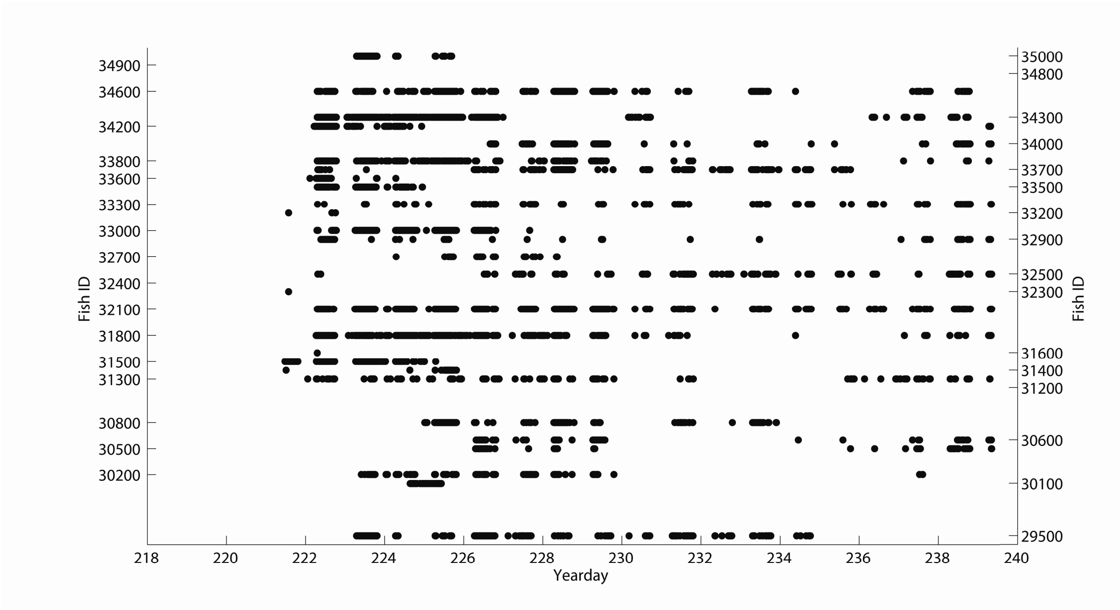

Figure F.29. The timing of all schooling events for Fish 34900 over the period August 8-27, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

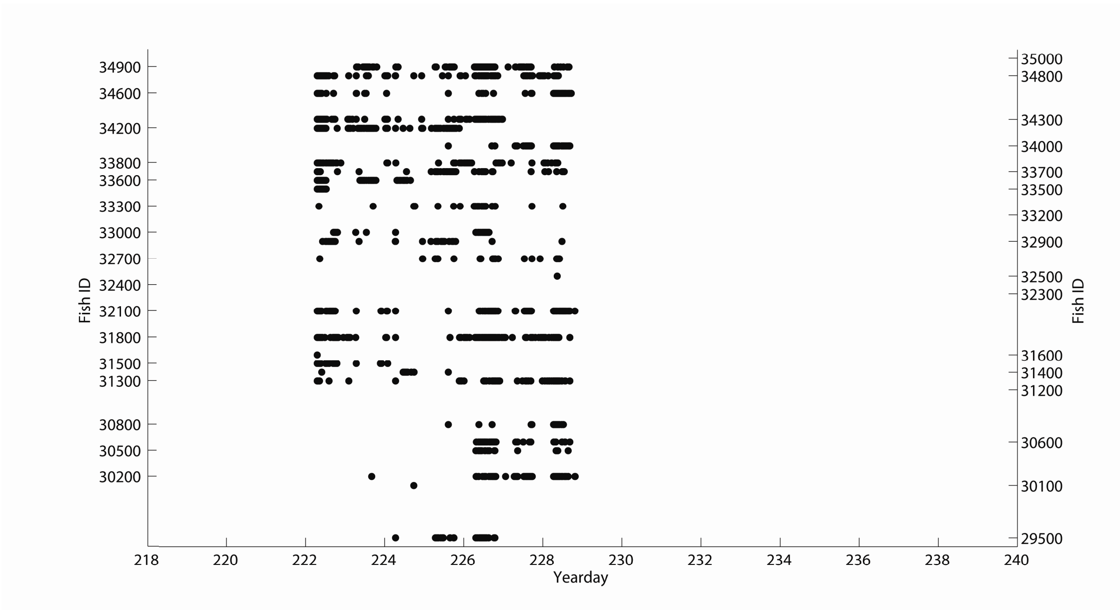

Figure F.30. The timing of all schooling events for Fish 35000 over the period August 9-16, 2005. Each circle indicates one localization where the two fish were 36m or less from each other.

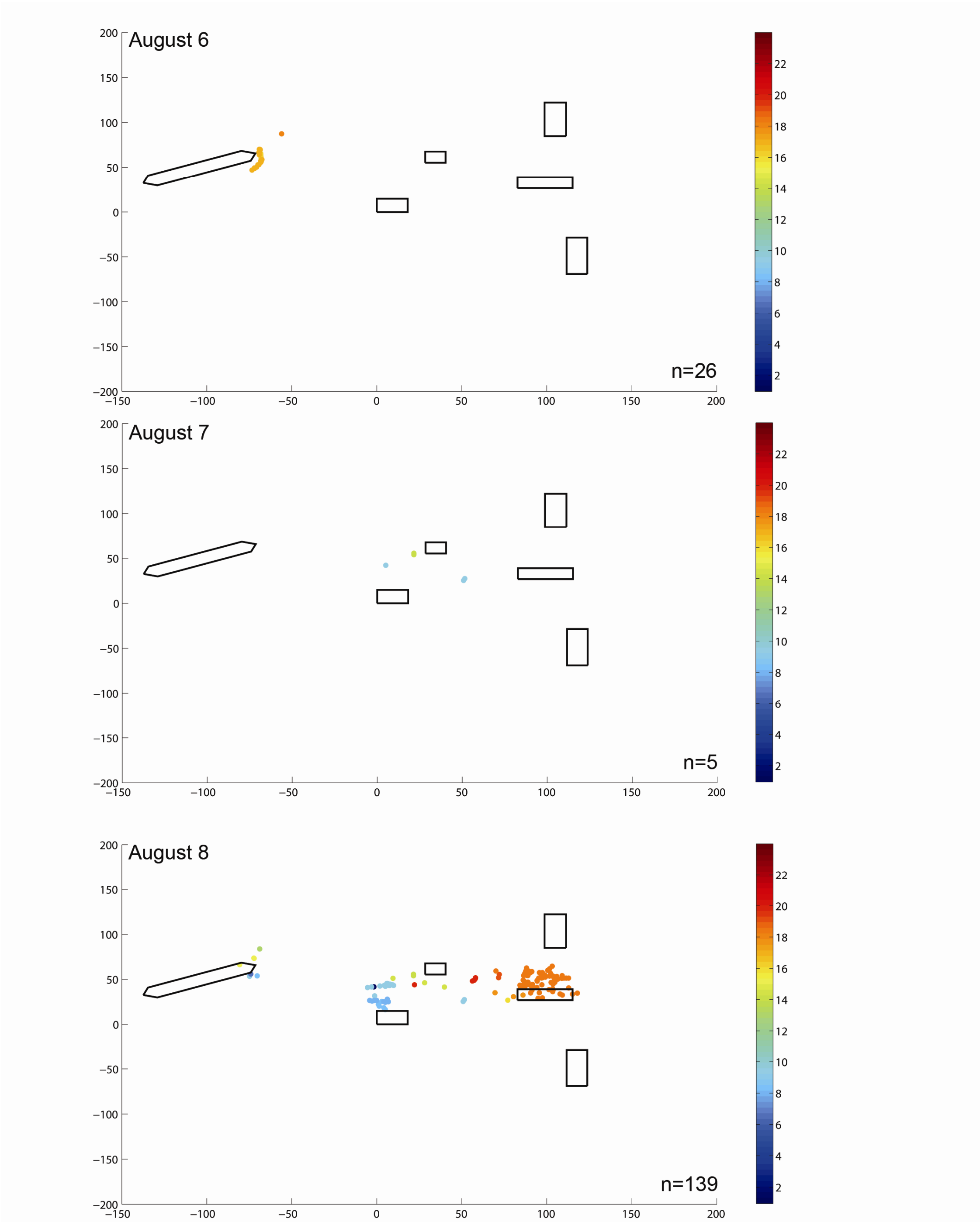

Figure F.31. The location of all 36m schooling events of tagged blue runner during the period August 6-8, 2005 are plotted on a continuum with color representing time of day. The location of the platforms is denoted by the black boxes.

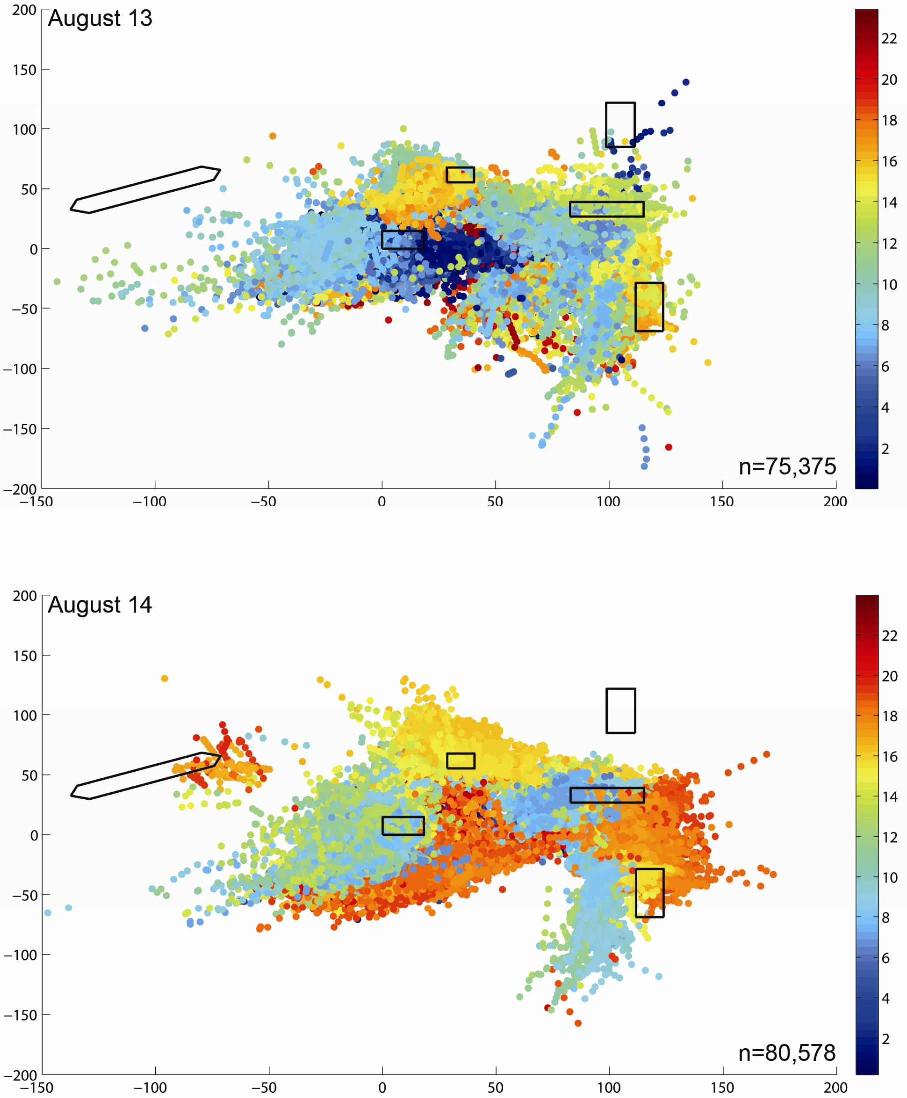

Figure F.32. The location of all 36m schooling events of tagged blue runner during the period August 13-14, 2005 are plotted on a continuum with color representing time of day. The location of the platforms is denoted by the black boxes.

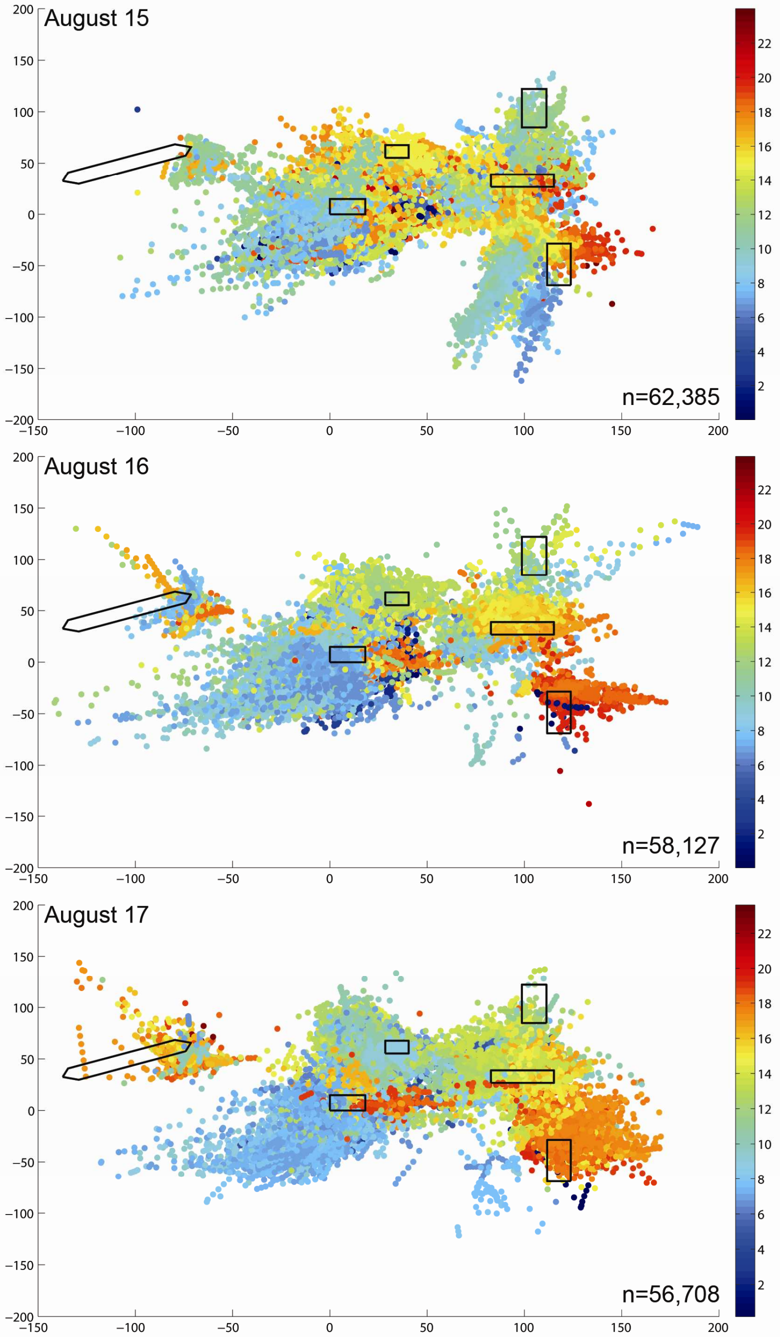

Figure F.33. The location of all 36m schooling events of tagged blue runner during the period August 15-17, 2005 are plotted on a continuum with color representing time of day. The location of the platforms is denoted by the black boxes.

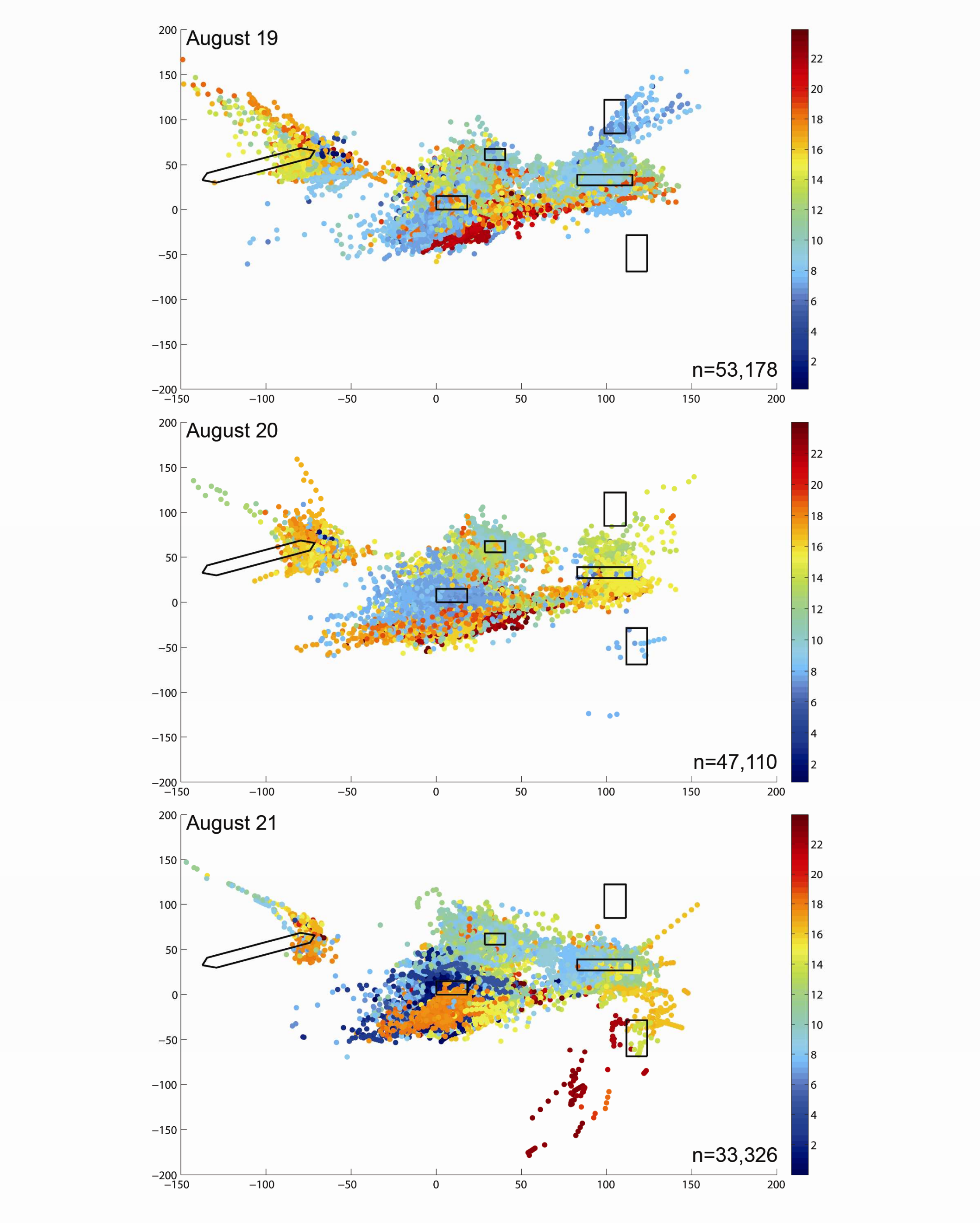

Figure F.34. The location of all 36m schooling events of tagged blue runner during the period August 19-21, 2005 are plotted on a continuum with color representing time of day. The location of the platforms is denoted by the black boxes.

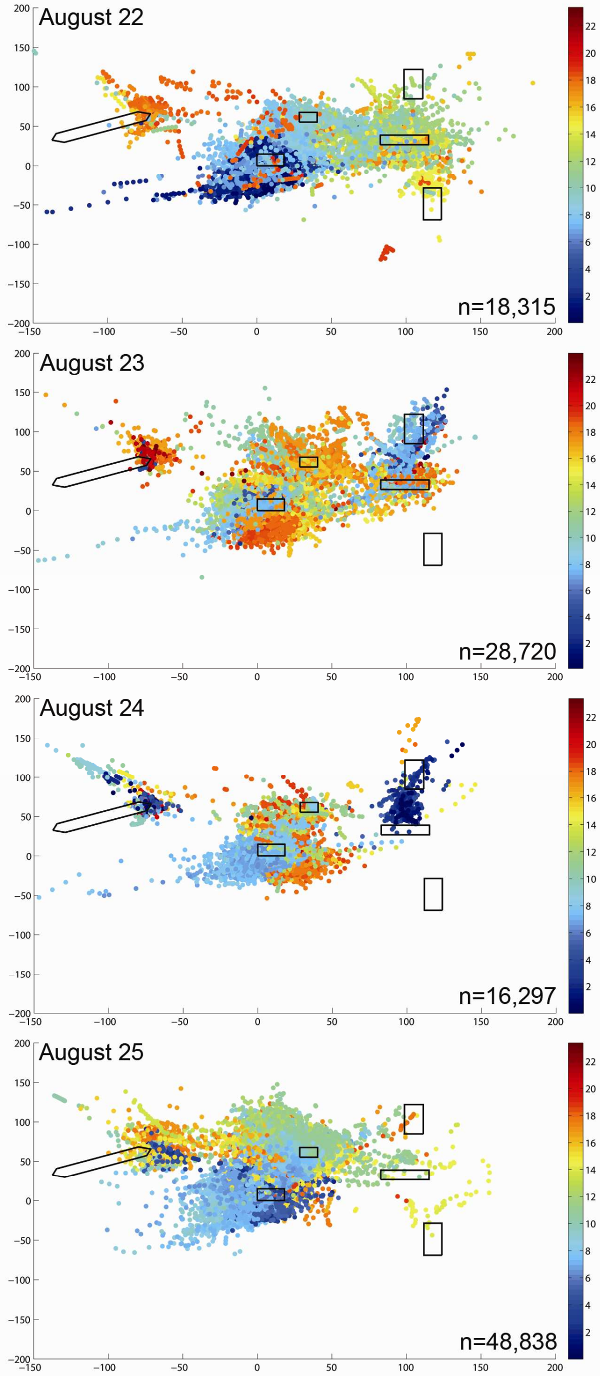

Figure F.35. The location of all 36m schooling events of tagged blue runner during the period August 22-25, 2005 are plotted on a continuum with color representing time of day. The location of the platforms is denoted by the black boxes.

APPENDIX G. ADDITIONAL FIGURES FOR CHAPTER 4

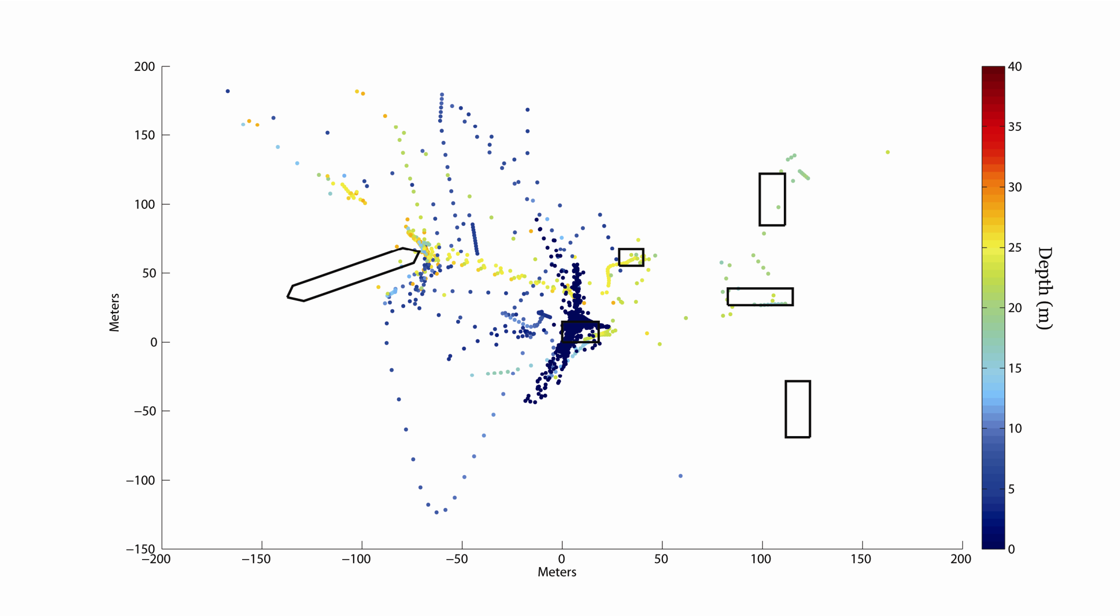

Figure G.1. The nighttime location solutions of Fish 29500 during the entire study period (August 10 – 21, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

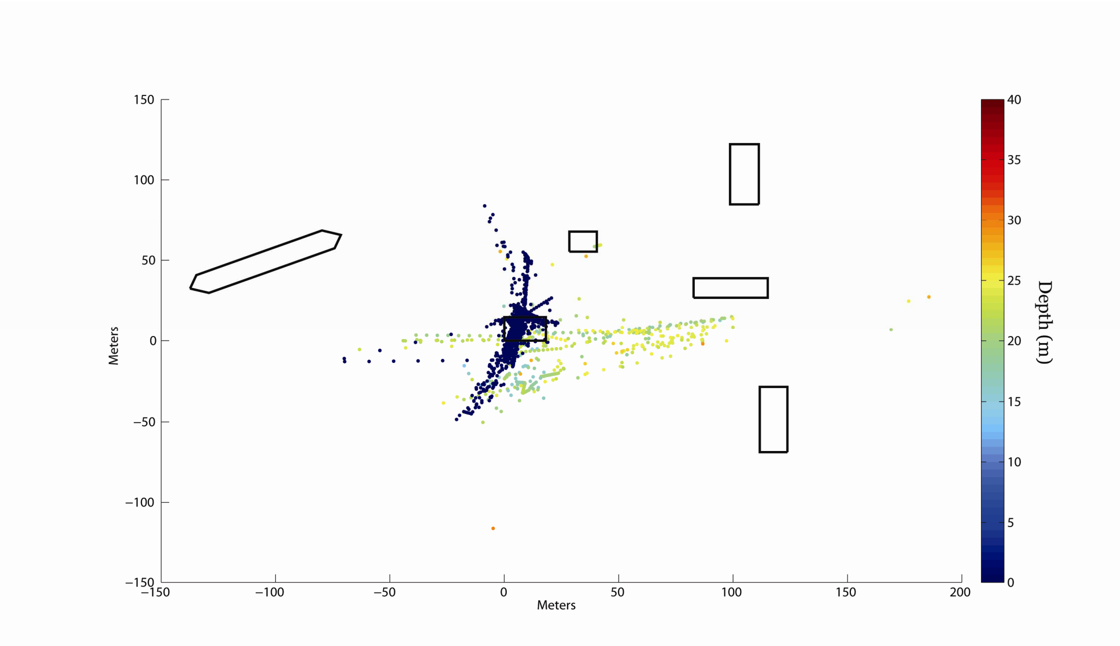

Figure G.2. The nighttime location solutions of Fish 30200 during the entire study period (August 10 – 25, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

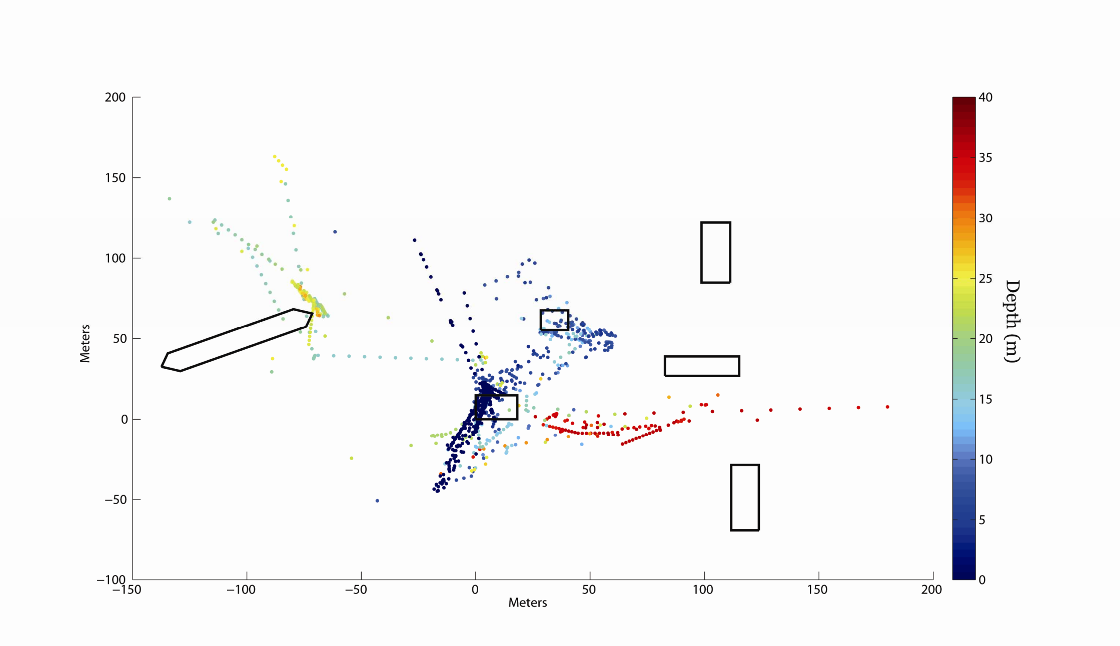

Figure G.3. The nighttime location solutions of Fish 30500 during the entire study period (August 13 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

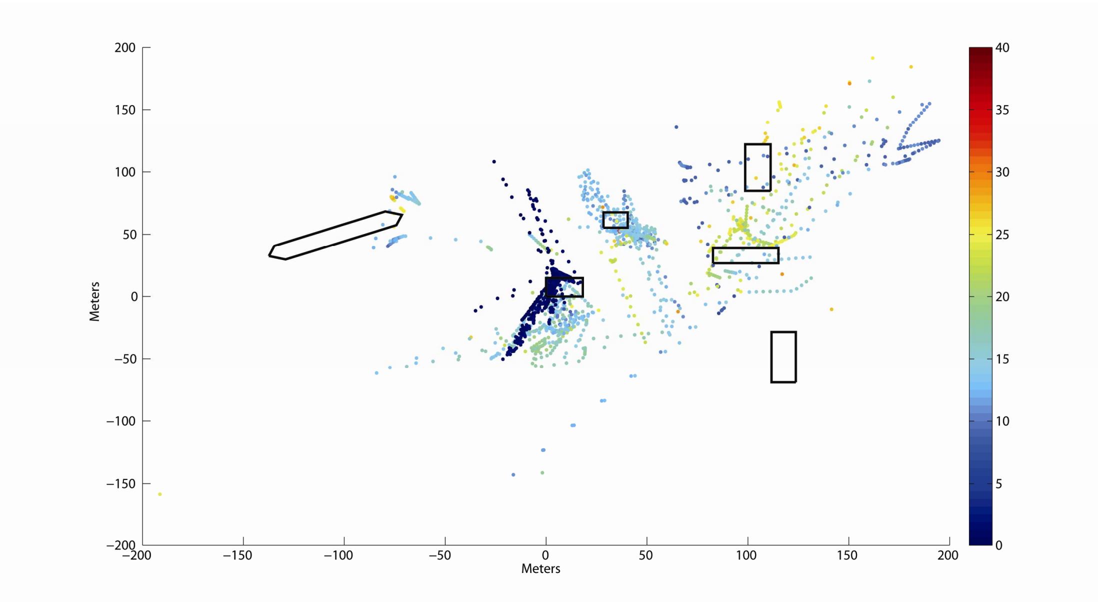

Figure G.4. The nighttime location solutions of Fish 30600 during the entire study period (August 13 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

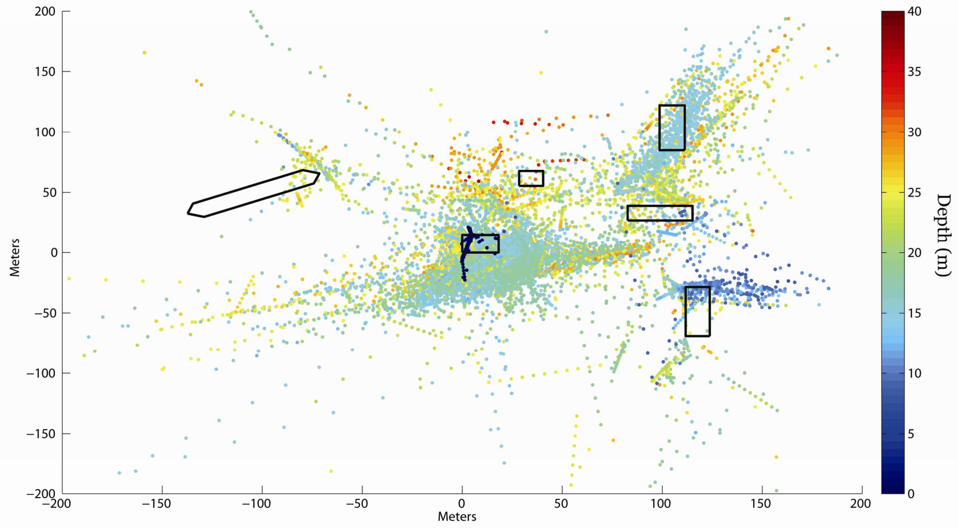

Figure G.5. The nighttime location solutions of Fish 30800 during the entire study period (August 13 – 24, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

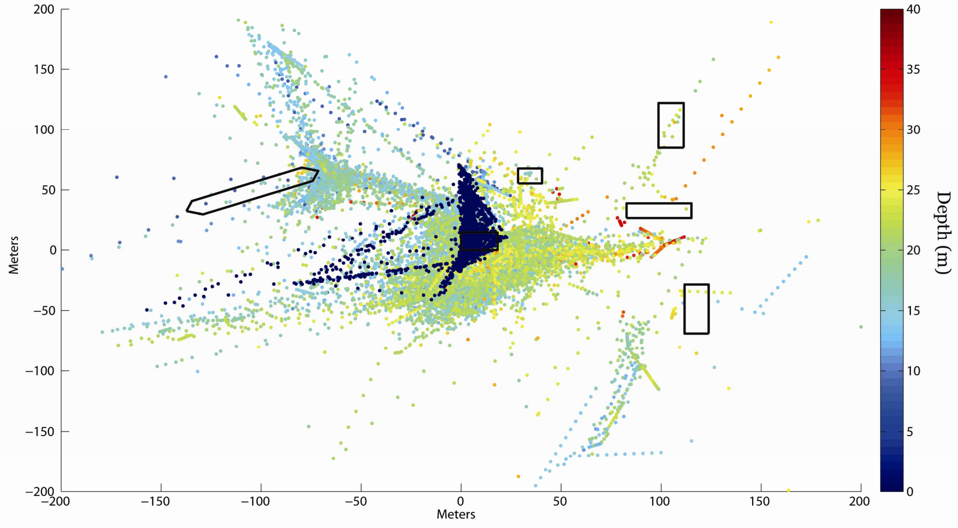

Figure G.6. The nighttime location solutions of Fish 31300 during the entire study period (August 8 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

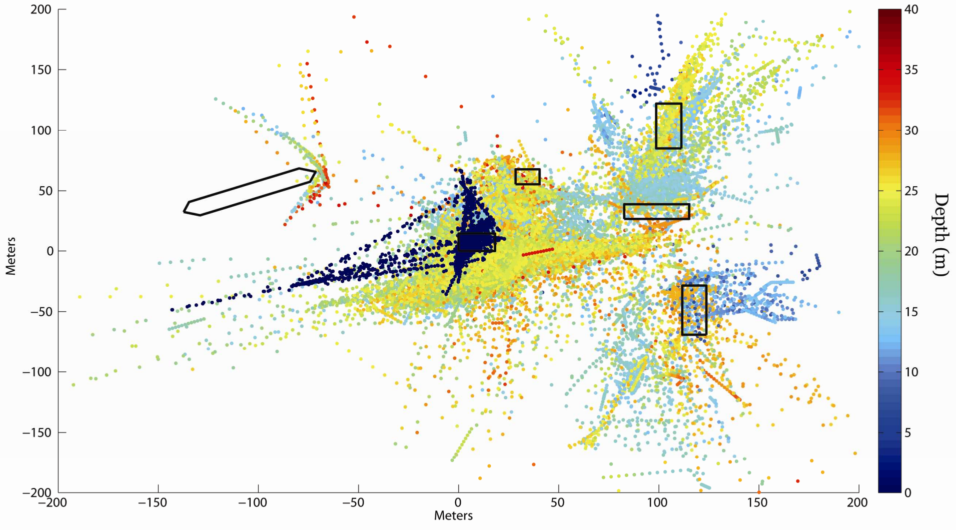

Figure G.7. The nighttime location solutions of Fish 31800 during the entire study period (August 8 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

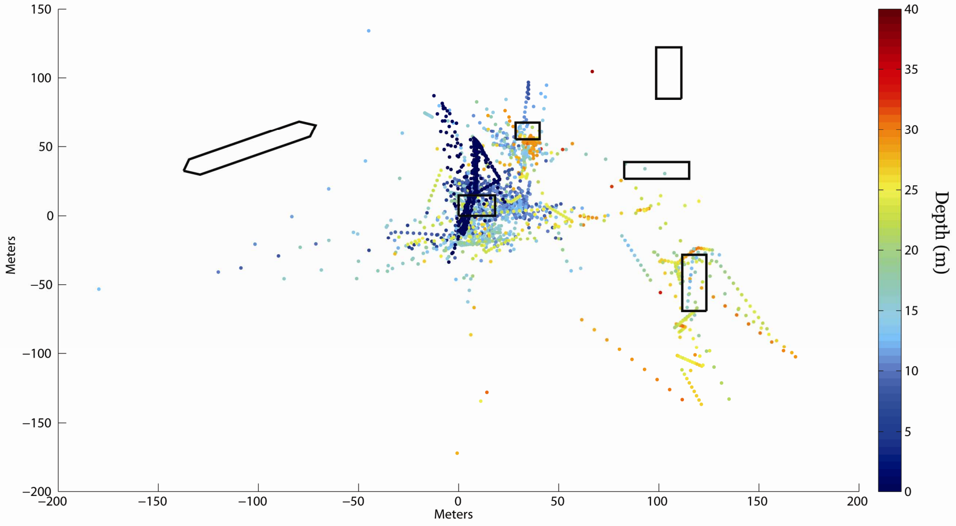

Figure G.8. The nighttime location solutions of Fish 32100 during the entire study period (August 9 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

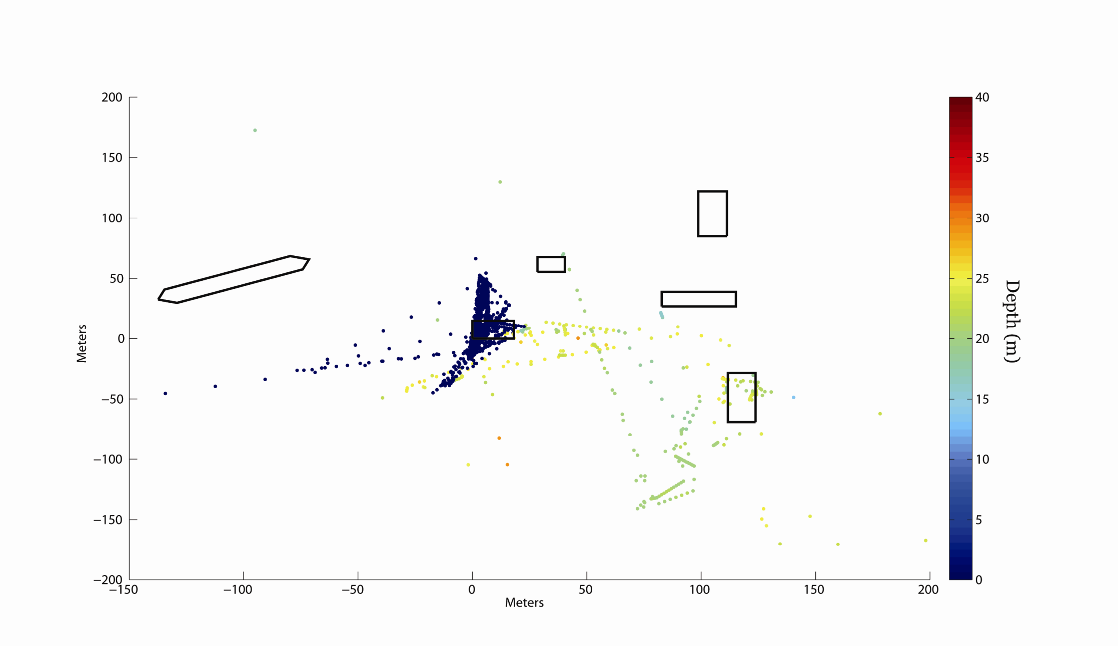

Figure G.9. The nighttime location solutions of Fish 32700 during the entire study period (August 8 – 16, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

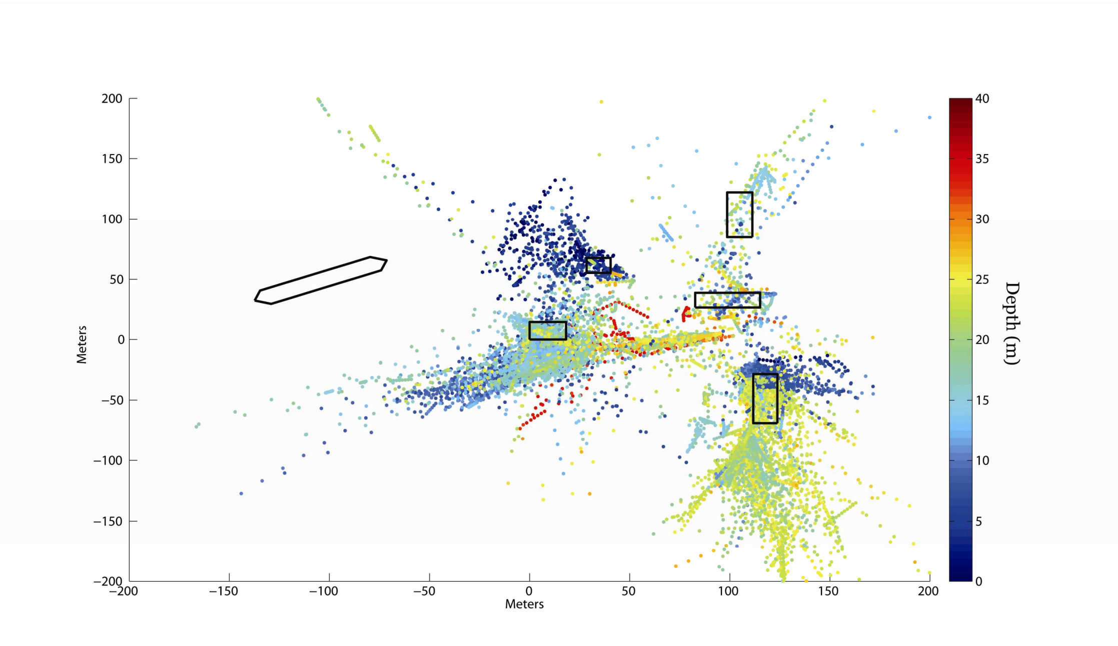

Figure G.10. The nighttime location solutions of Fish 32900 during the entire study period (August 10 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

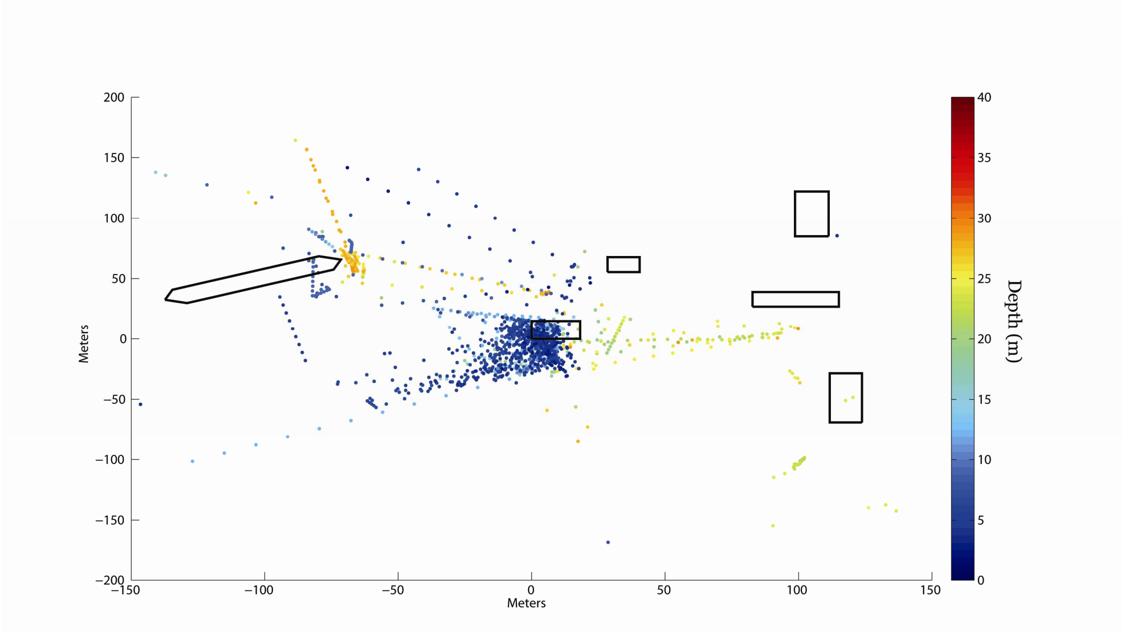

Figure G.11. The nighttime location solutions of Fish 33000 during the entire study period (August 8 – 26, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

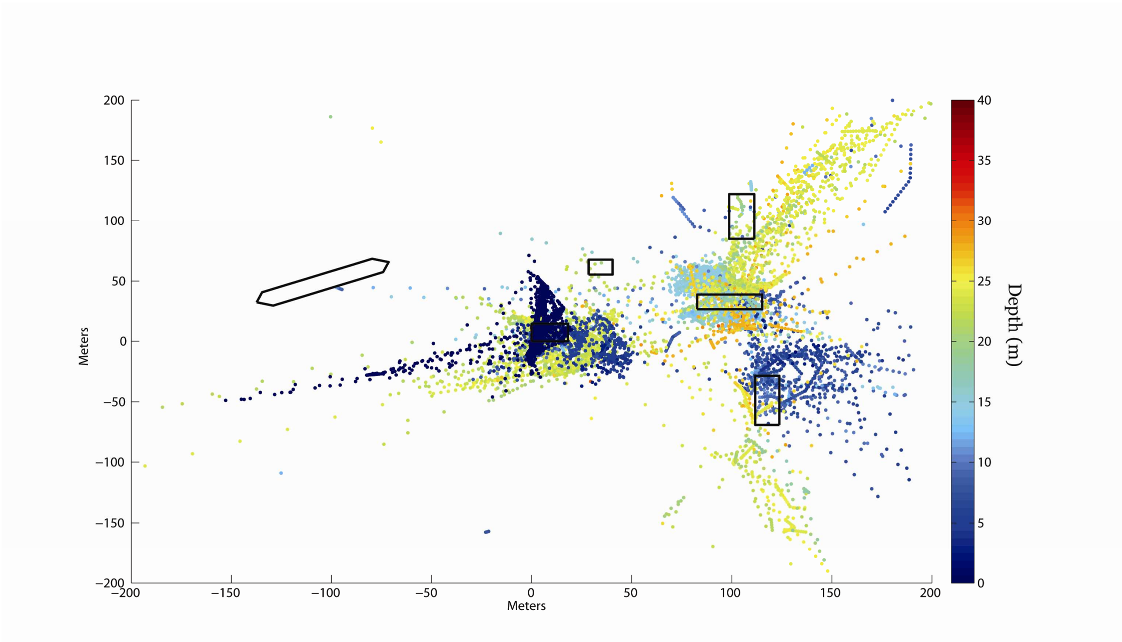

Figure G.12. The nighttime location solutions of Fish 33700 during the entire study period (August 8 – 23, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

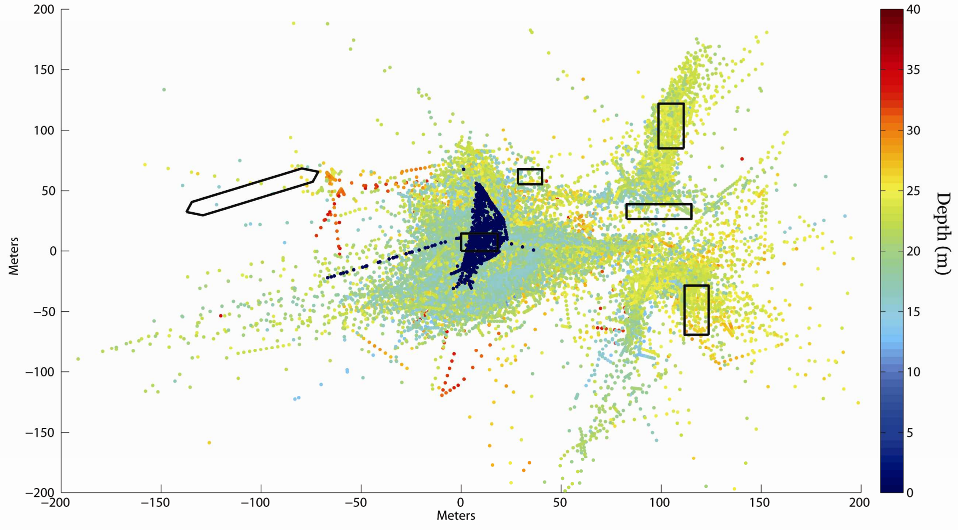

Figure G.13. The nighttime location solutions of Fish 34000 during the entire study period (August 9 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

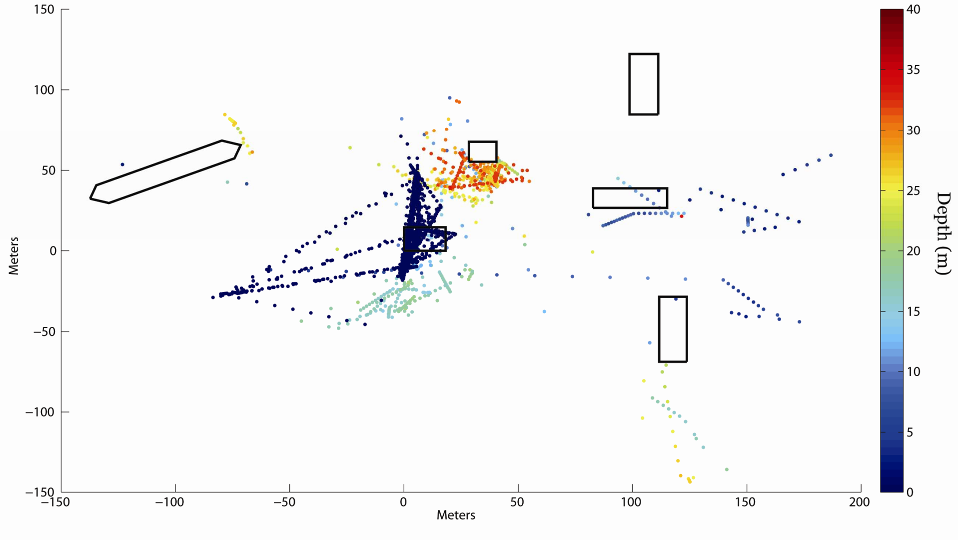

Figure G.14. The nighttime location solutions of Fish 34200 during the entire study period (August 8 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

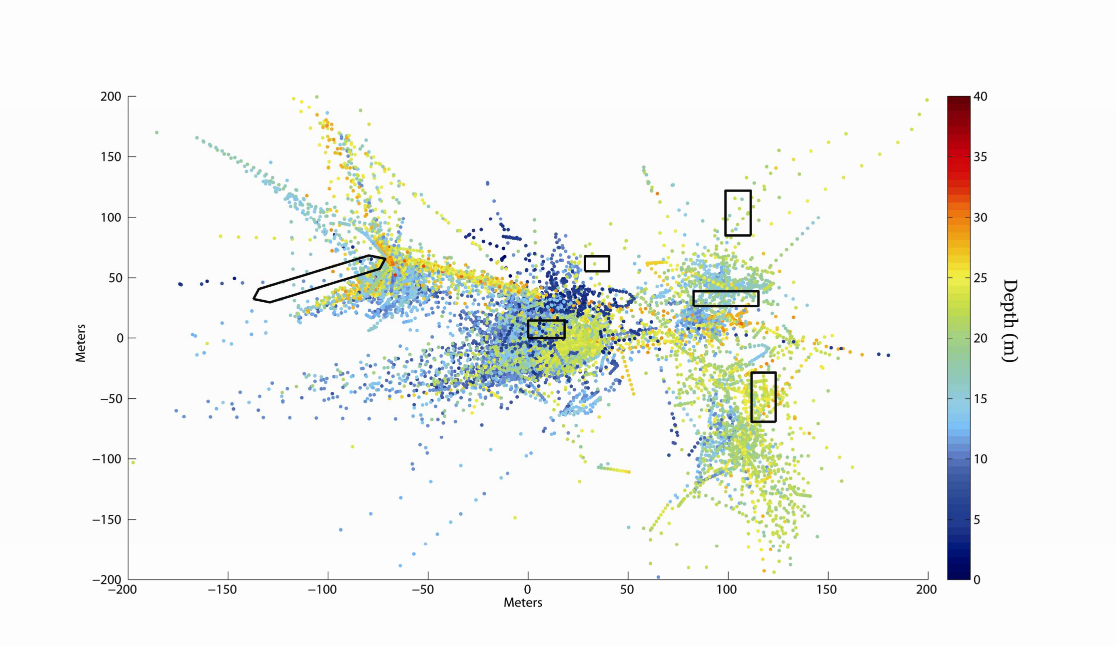

Figure G.15. The nighttime location solutions of Fish 34300 during the entire study period (August 8 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

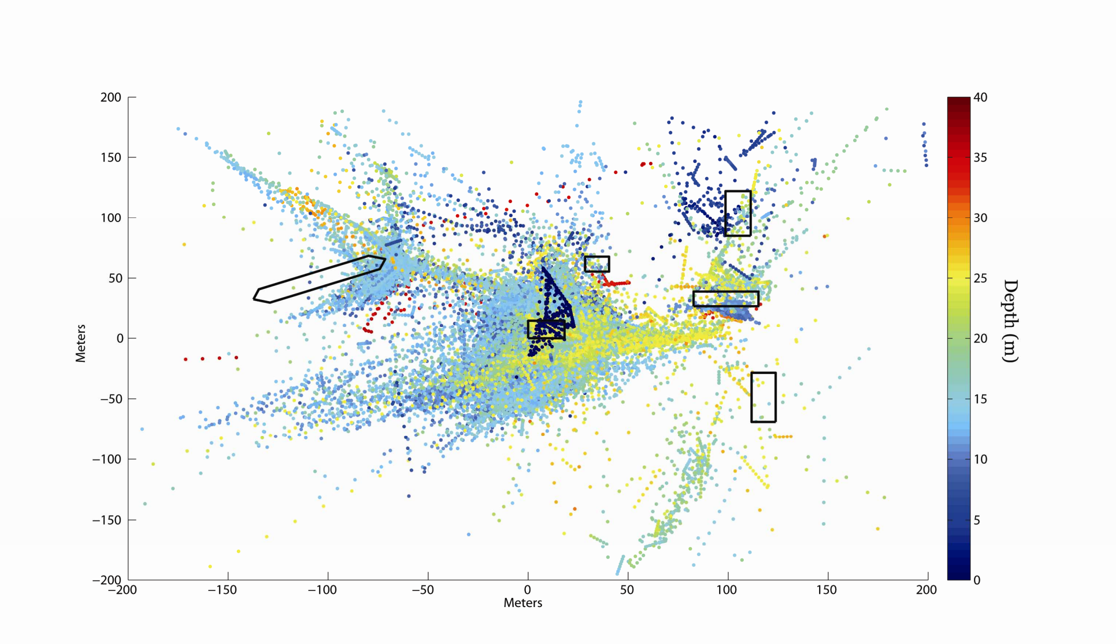

Figure G.16. The nighttime location solutions of Fish 34600 during the entire study period (August 9 – 26, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

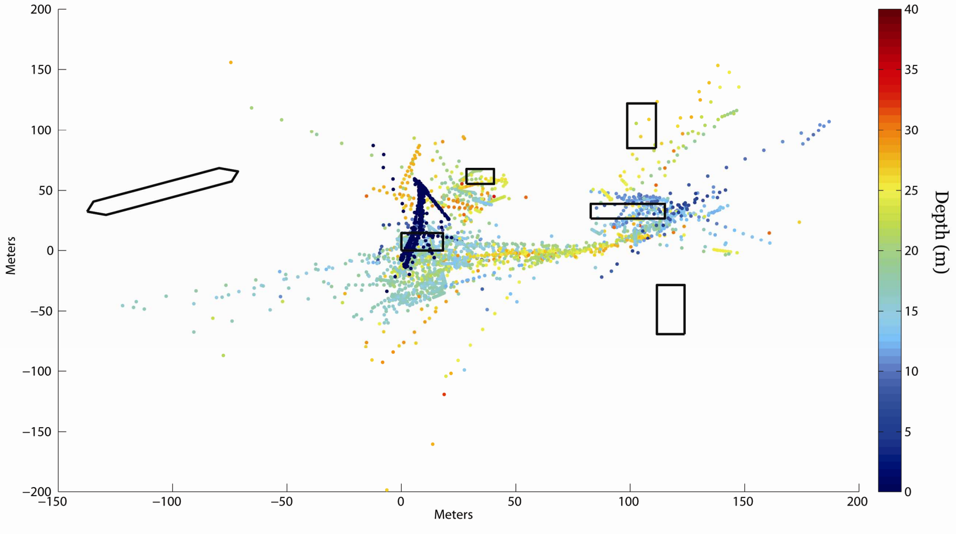

Figure G.17. The nighttime location solutions of Fish 34800 during the entire study period (August 9 – 26, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

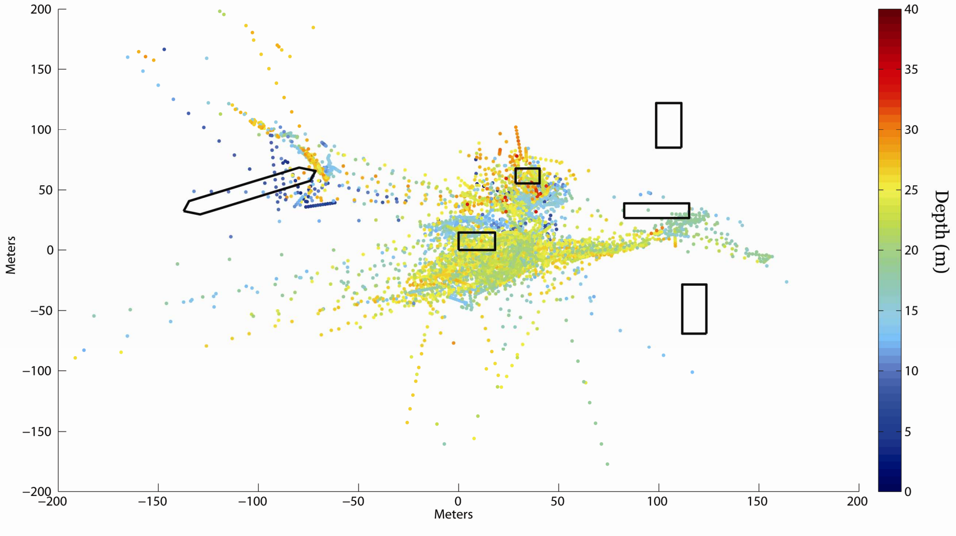

Figure G.18. The nighttime location solutions of Fish 34900 during the entire study period (August 8 – 27, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

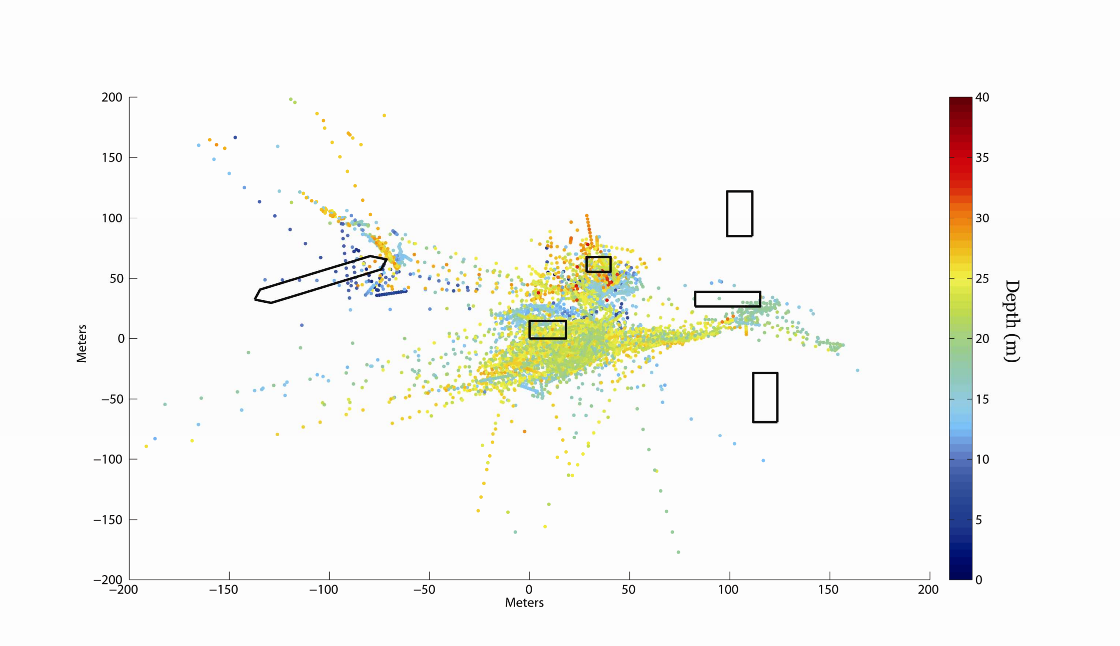

Figure G.19. The nighttime location solutions of Fish 35000 during the entire study period (August 9 – 16, 2005) in relation to the platforms are represented by dots color coded by depth, with blue being shallower and red being deeper.

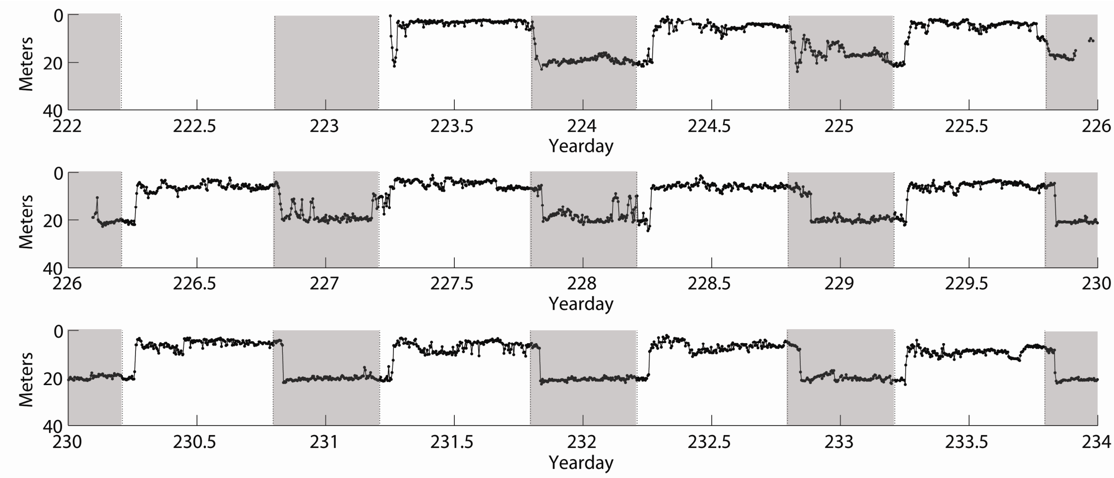

Figure G.20. The day and night vertical distribution of Fish 29500 in 2005 are represented with the shaded bars indicating night.

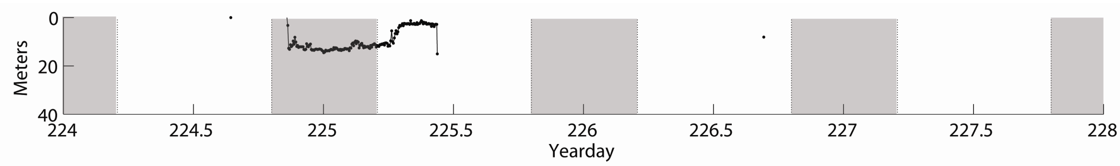

Figure G.21. The day and night vertical distribution of Fish 30100 in 2005 are represented with the shaded bars indicating night.

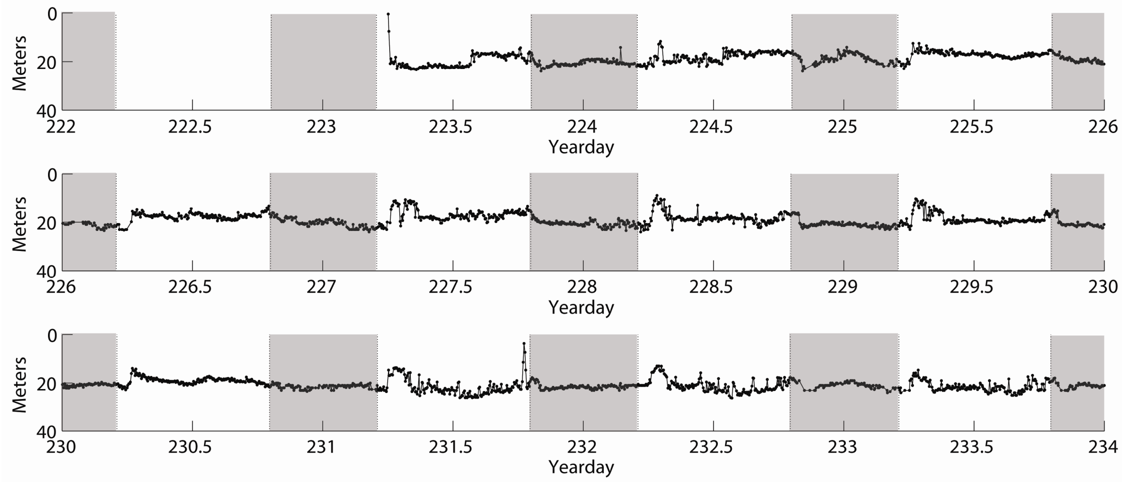

Figure G.22. The day and night vertical distribution of Fish 30200 in 2005 are represented with the shaded bars indicating night.

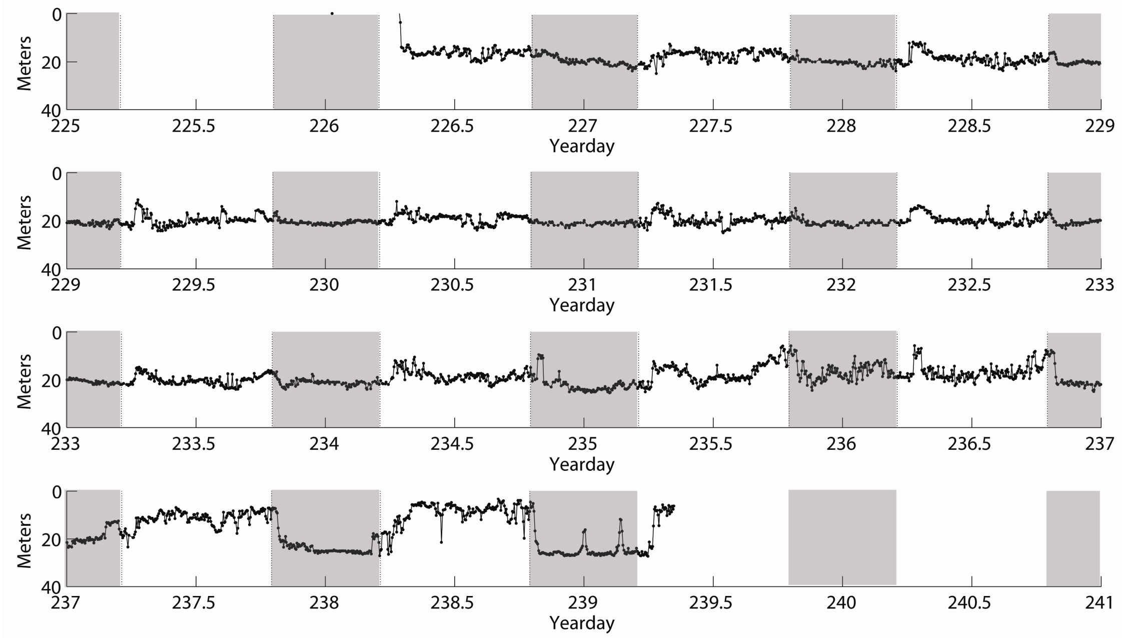

Figure G.23. The day and night vertical distribution of Fish 30500 in 2005 are represented with the shaded bars indicating night.

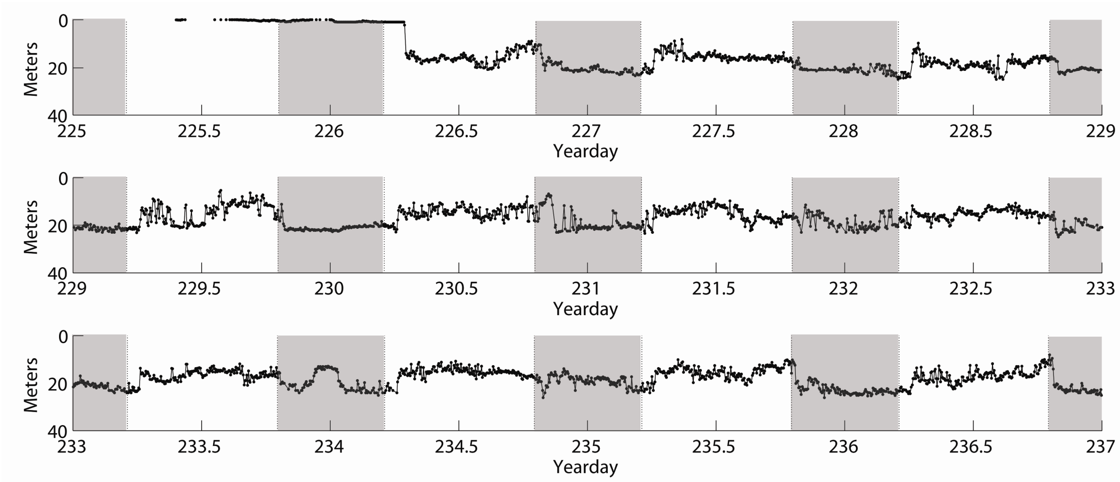

Figure G.24. The day and night vertical distribution of Fish 30600 in 2005 are represented with the shaded bars indicating night.

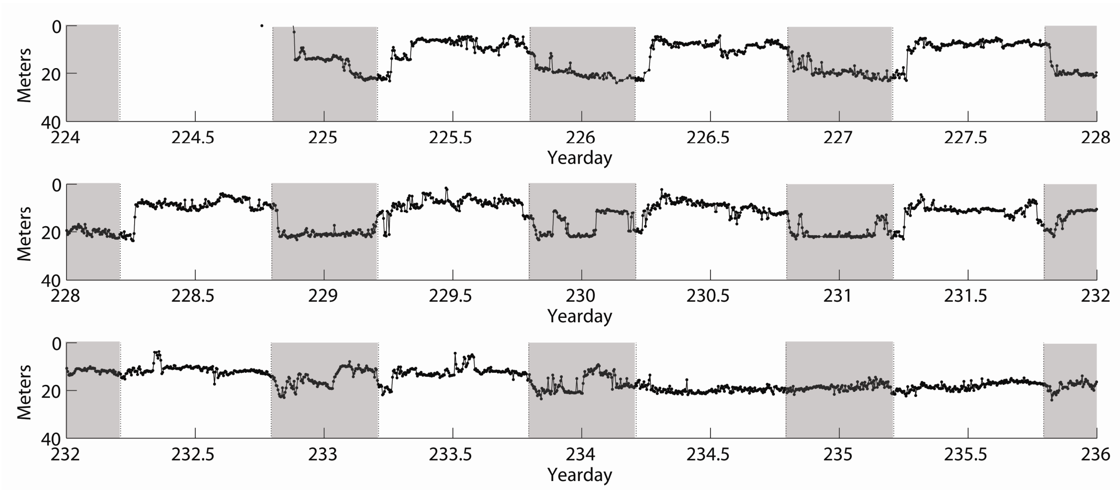

Figure G.25. The day and night vertical distribution of Fish 30800 in 2005 are represented with the shaded bars indicating night.

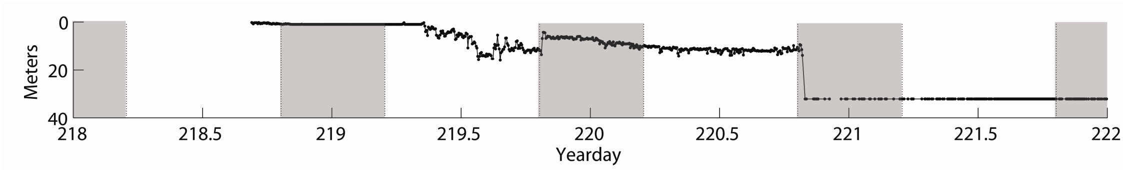

Figure G.26. The day and night vertical distribution of Fish 31200 in 2005 are represented with the shaded bars indicating night.

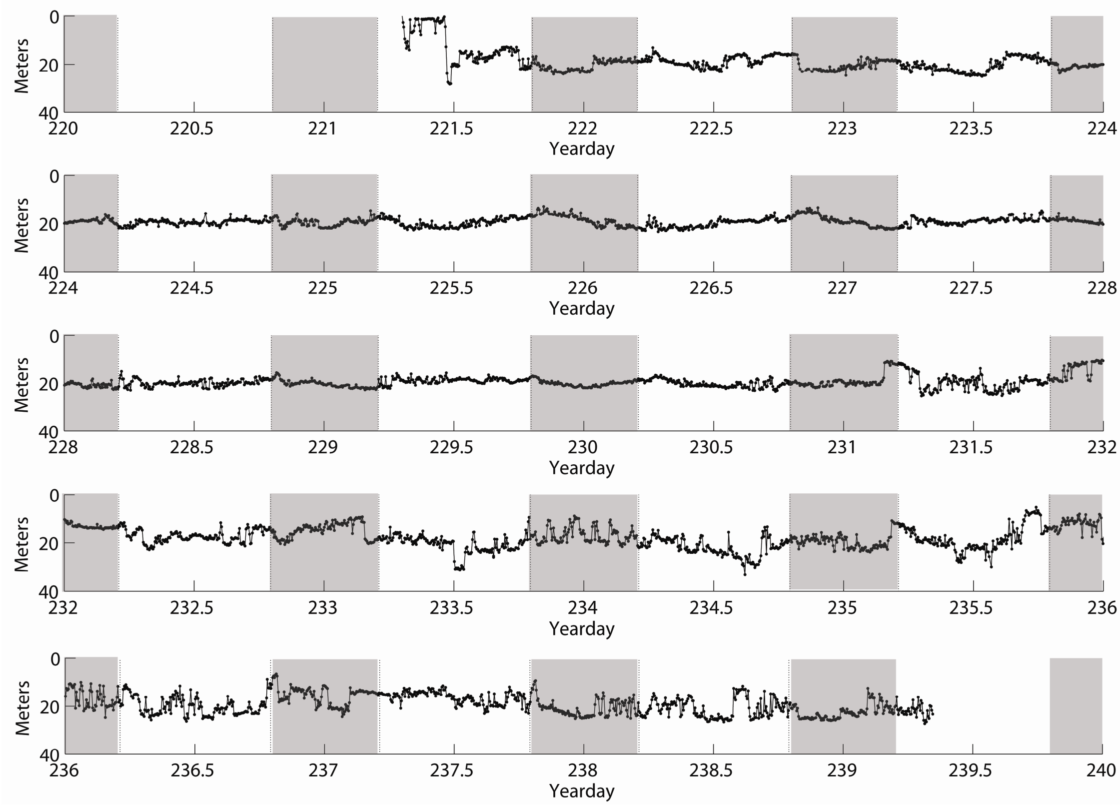

Figure G2.7. The day and night vertical distribution of Fish 31300 in 2005 are represented with the shaded bars indicating night.

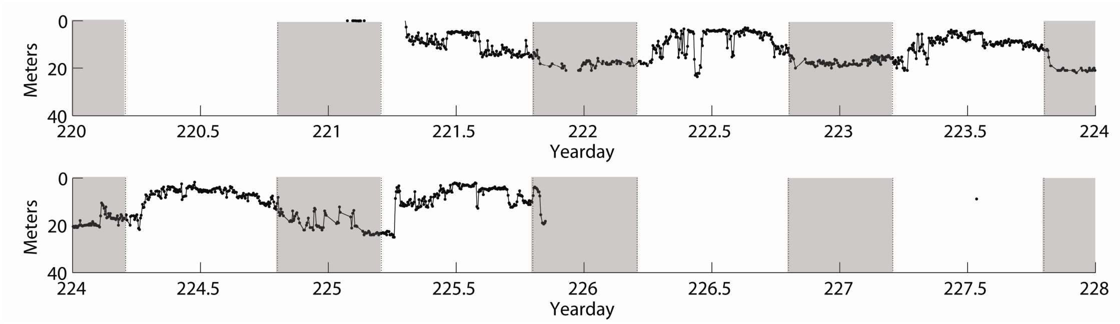

Figure G.28. The day and night vertical distribution of Fish 31400 in 2005 are represented with the shaded bars indicating night.

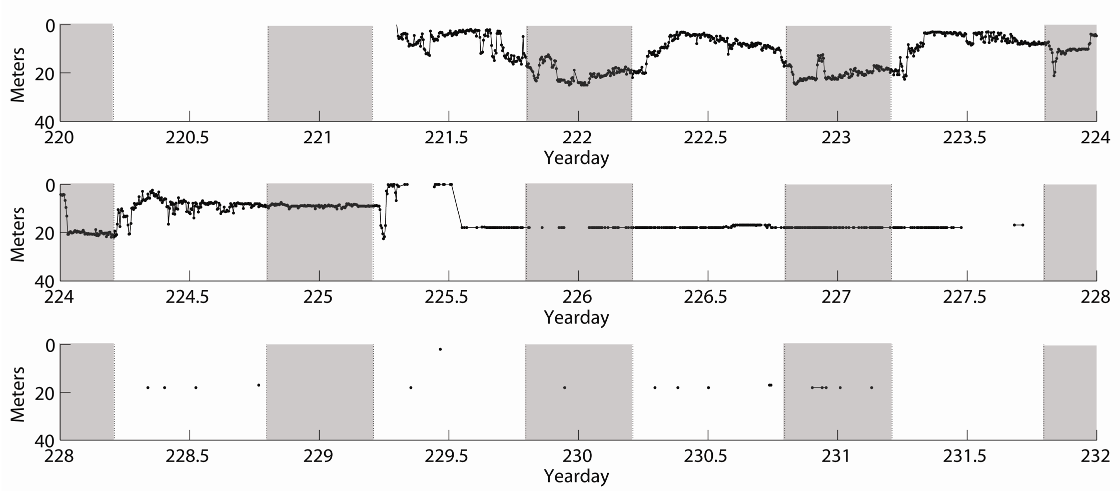

Figure G.29. The day and night vertical distribution of Fish 31500 in 2005 are represented with the shaded bars indicating night.

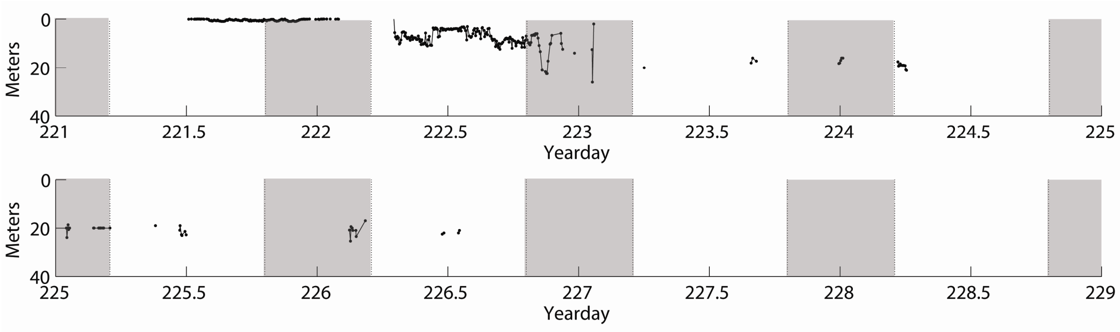

Figure G.30. The day and night vertical distribution of Fish 31600 in 2005 are represented with the shaded bars indicating night.

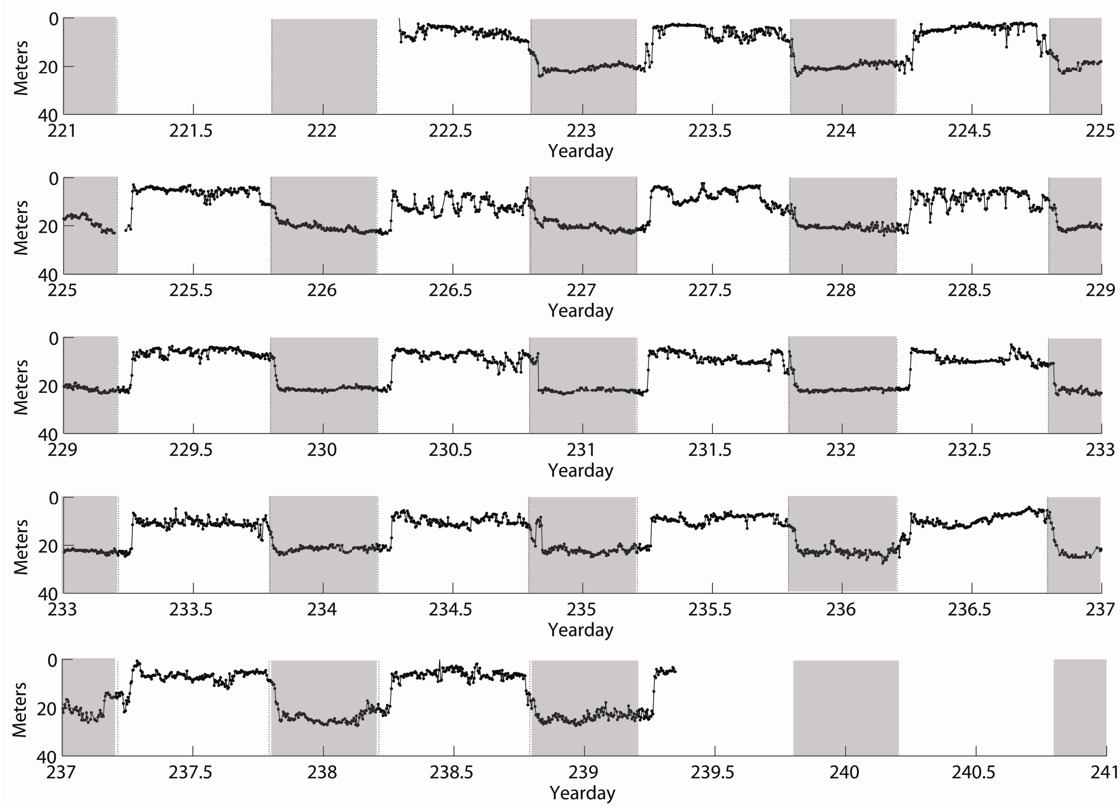

Figure G.31. The day and night vertical distribution of Fish 32100 in 2005 are represented with the shaded bars indicating night.

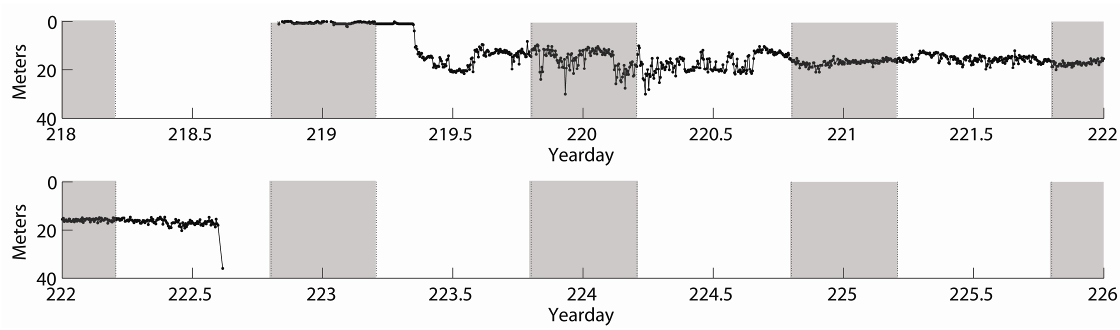

Figure G.32. The day and night vertical distribution of Fish 32300 in 2005 are represented with the shaded bars indicating night.

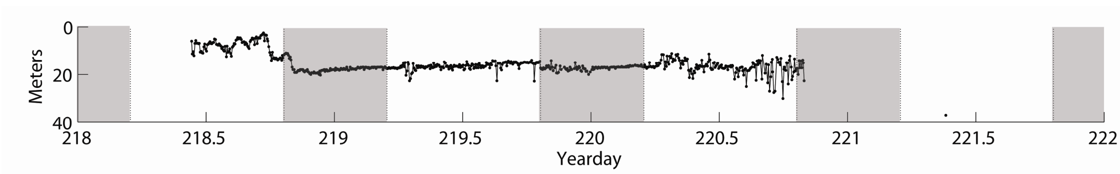

Figure G.33. The day and night vertical distribution of Fish 32400 in 2005 are represented with the shaded bars indicating night.

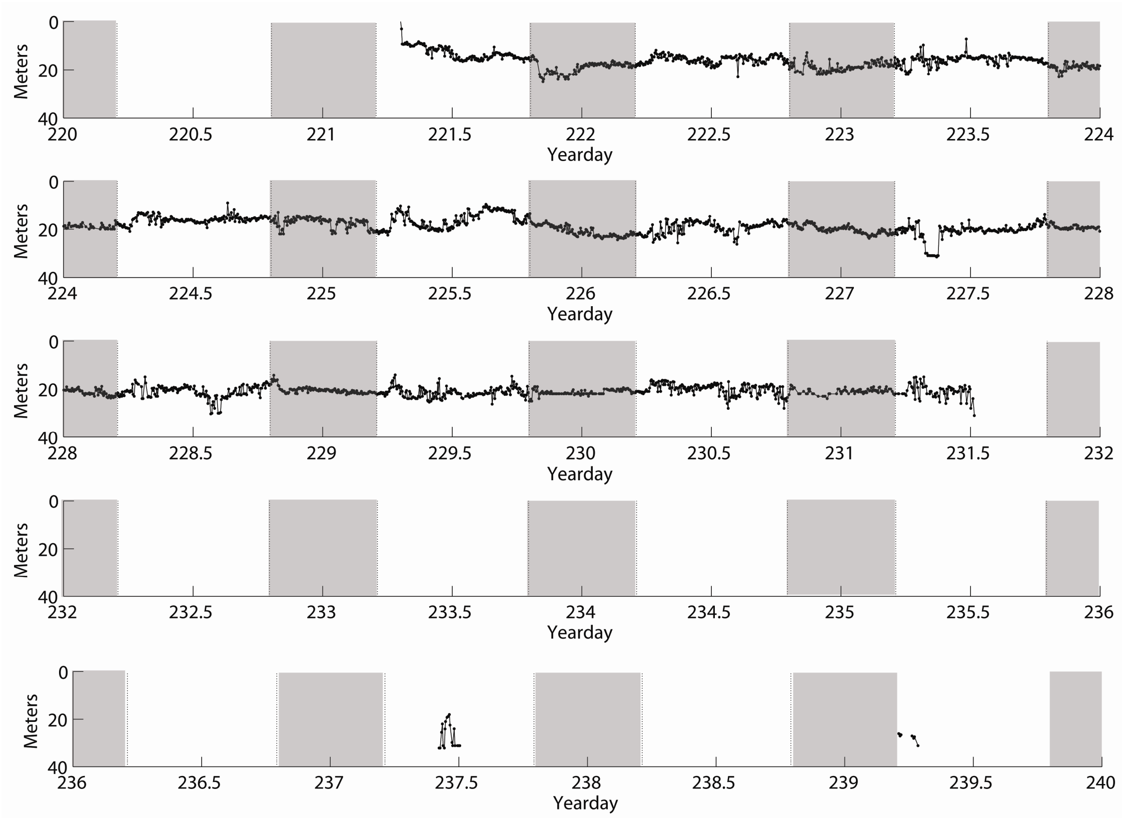

Figure G.34. The day and night vertical distribution of Fish 32700 in 2005 are represented with the shaded bars indicating night.

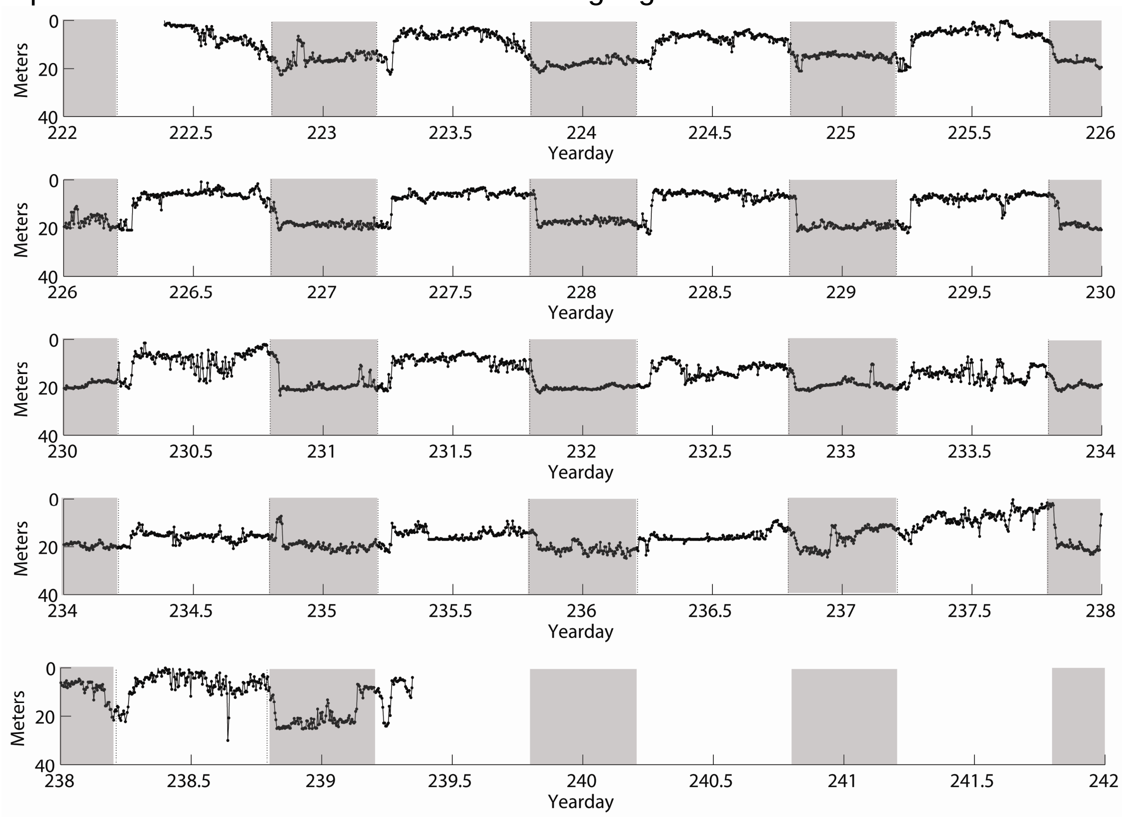

Figure G.35. The day and night vertical distribution of Fish 32900 in 2005 are represented with the shaded bars indicating night.

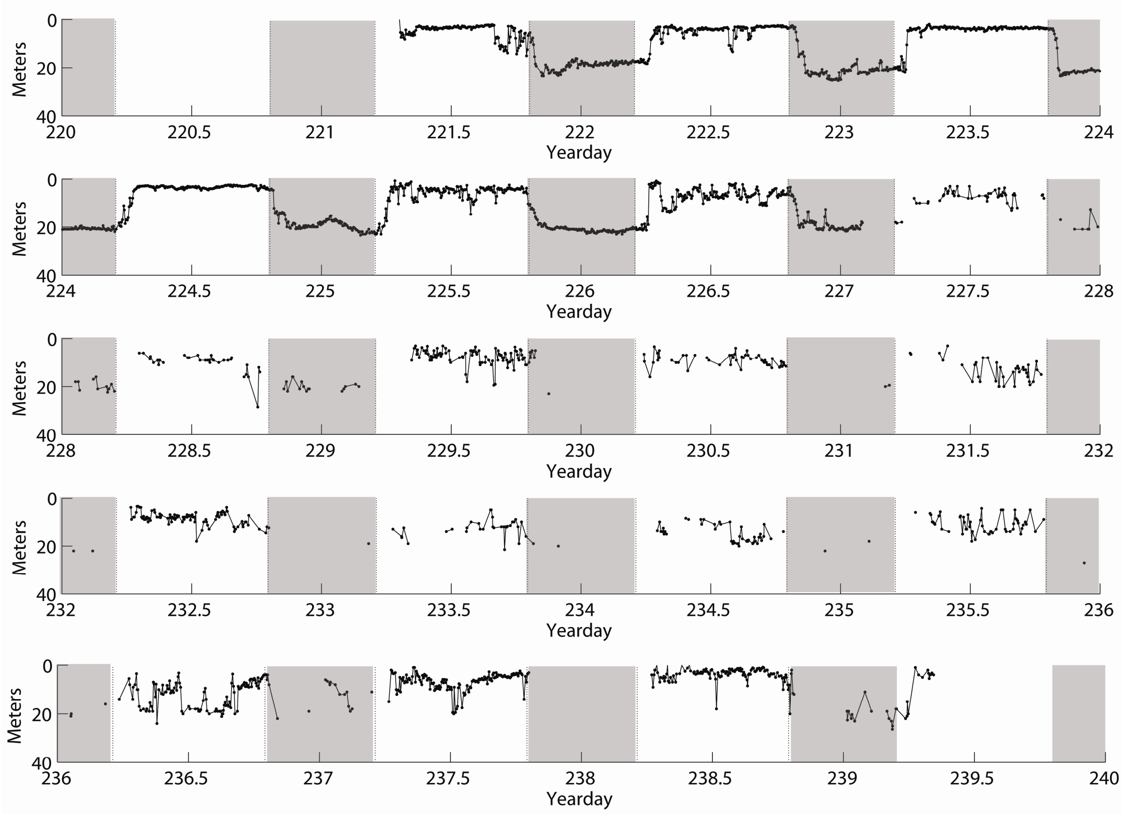

Figure G.36. The day and night vertical distribution of Fish 33000 in 2005 are represented with the shaded bars indicating night.

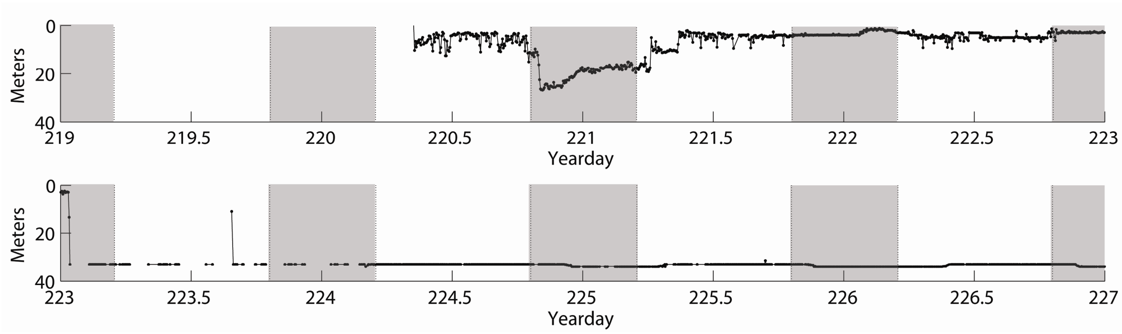

Figure G.37. The day and night vertical distribution of Fish 33200 in 2005 are represented with the shaded bars indicating night.

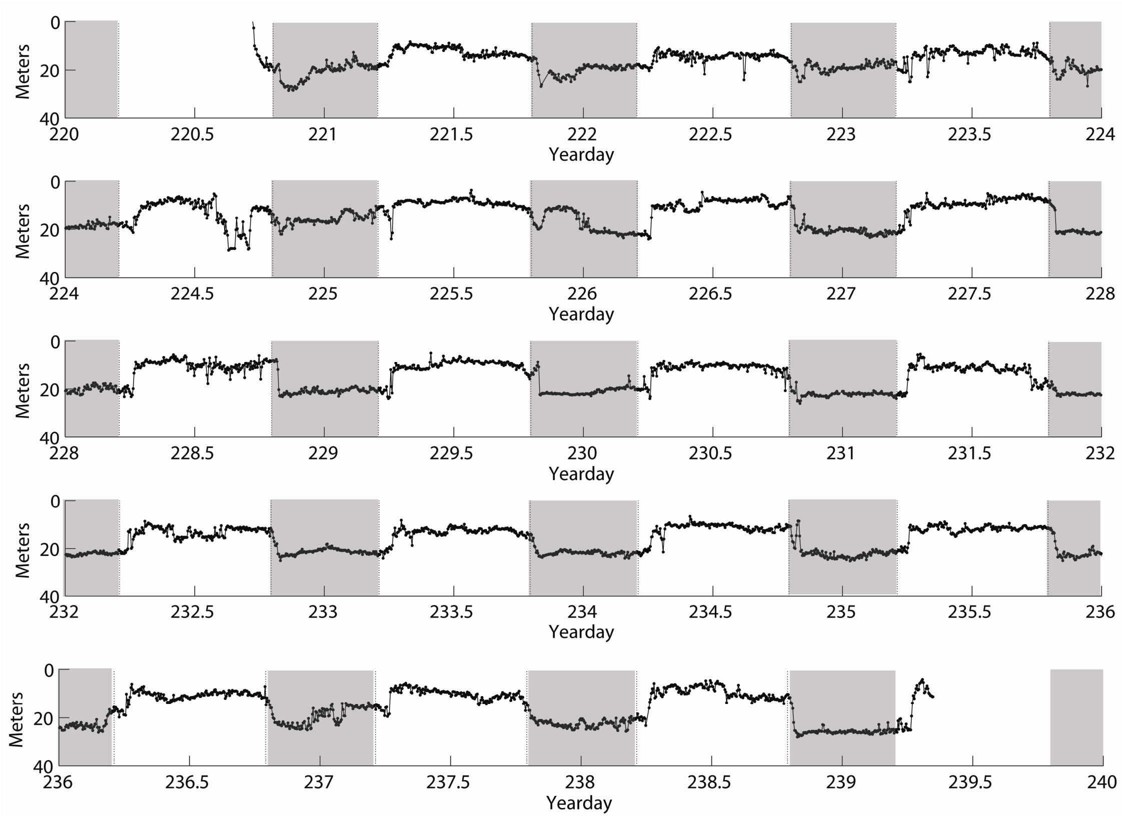

Figure G.38. The day and night vertical distribution of Fish 33300 in 2005 are represented with the shaded bars indicating night.

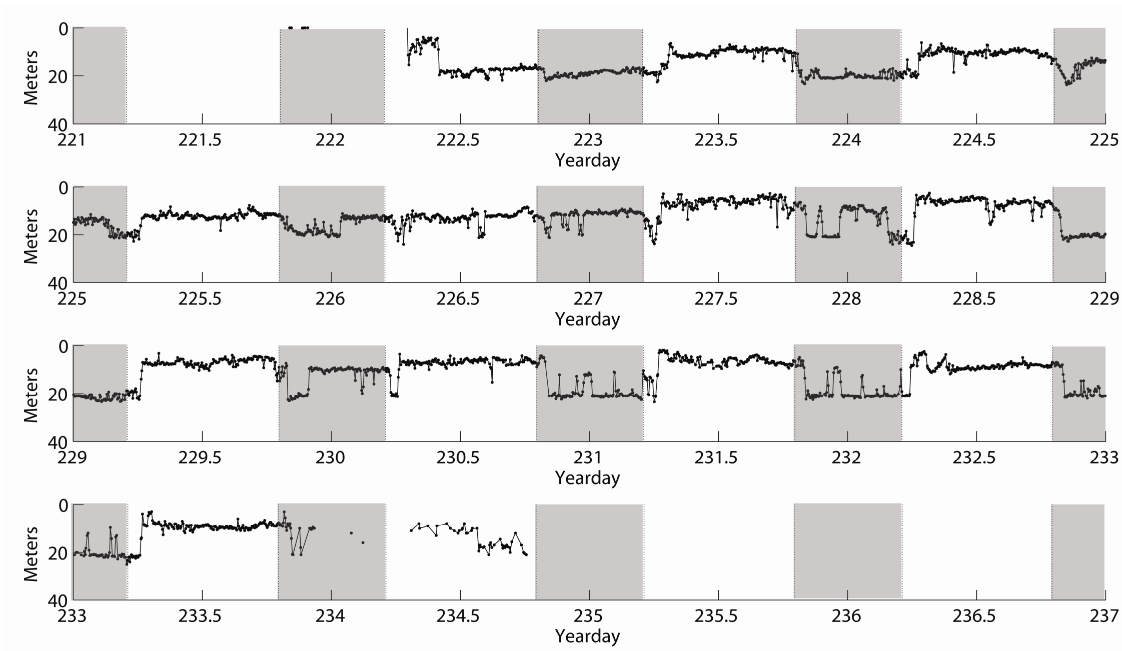

Figure G.39. The day and night vertical distribution of Fish 33500 in 2005 are represented with the shaded bars indicating night.

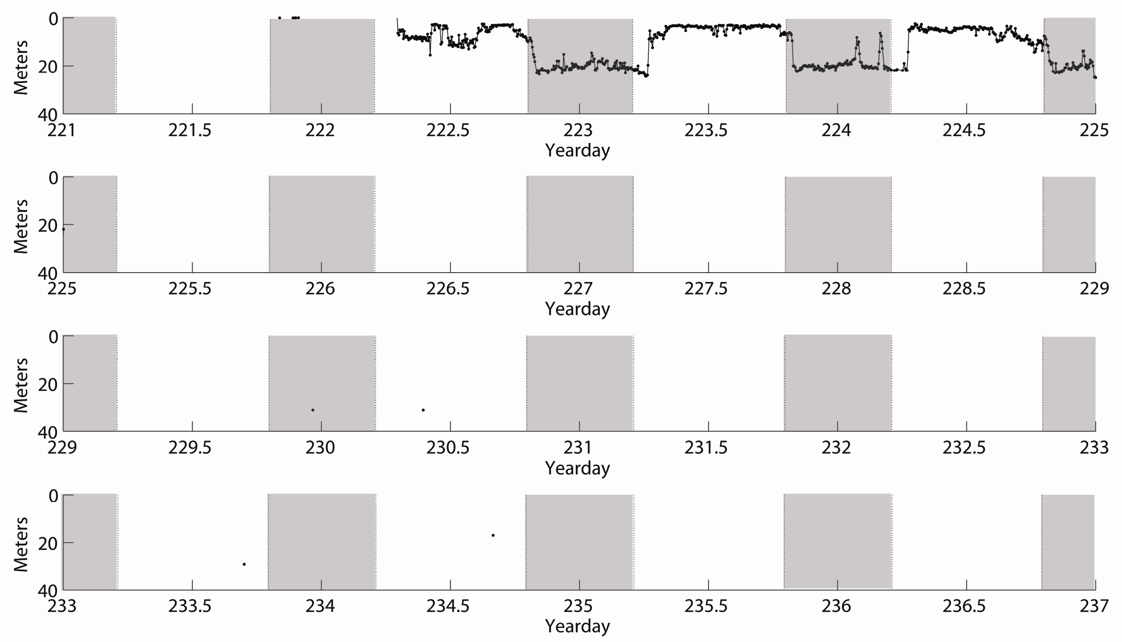

Figure G.40. The day and night vertical distribution of Fish 33600 in 2005 are represented with the shaded bars indicating night.

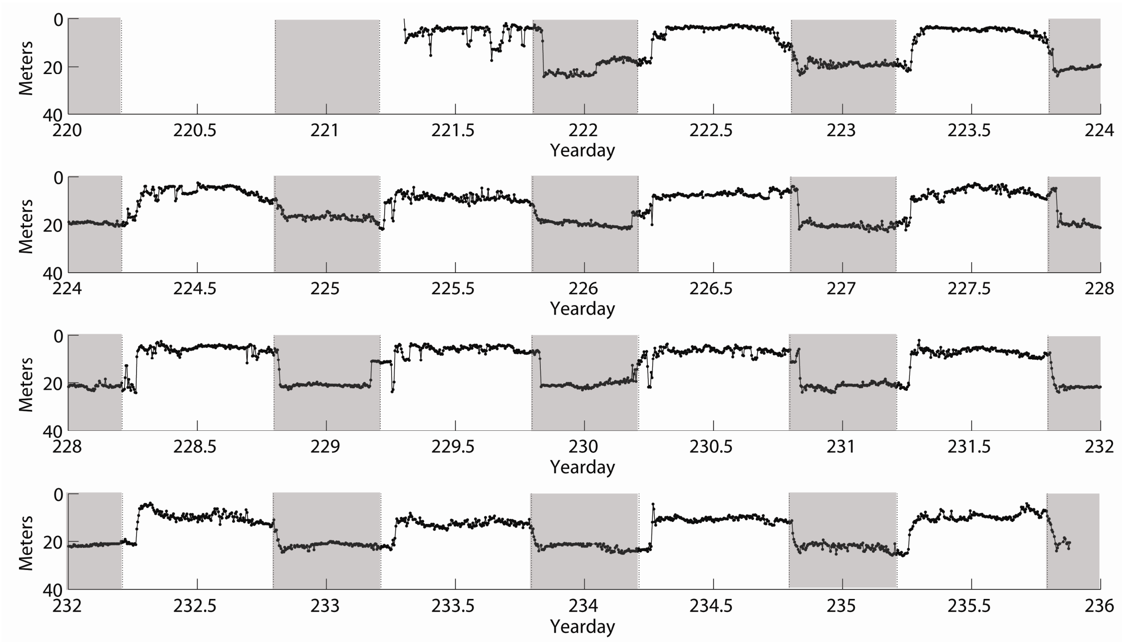

Figure G.41. The day and night vertical distribution of Fish 33700 in 2005 are represented with the shaded bars indicating night.

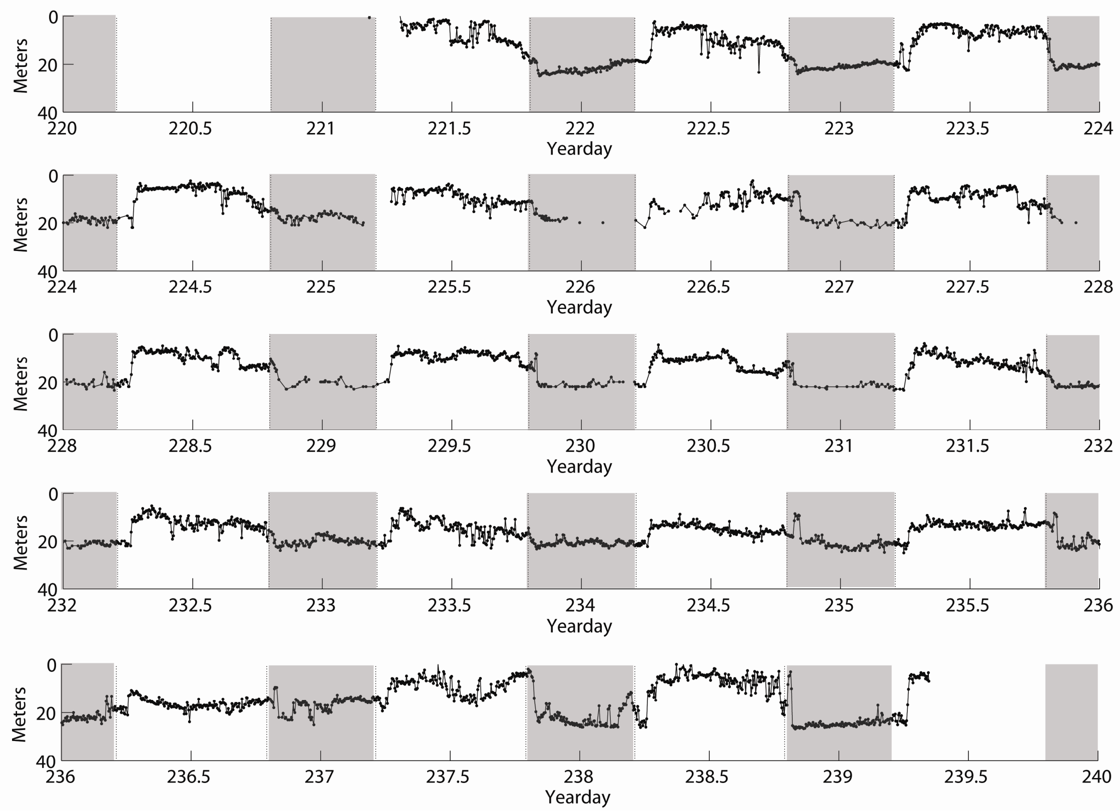

Figure G.42. The day and night vertical distribution of Fish 34200 in 2005 are represented with the shaded bars indicating night.

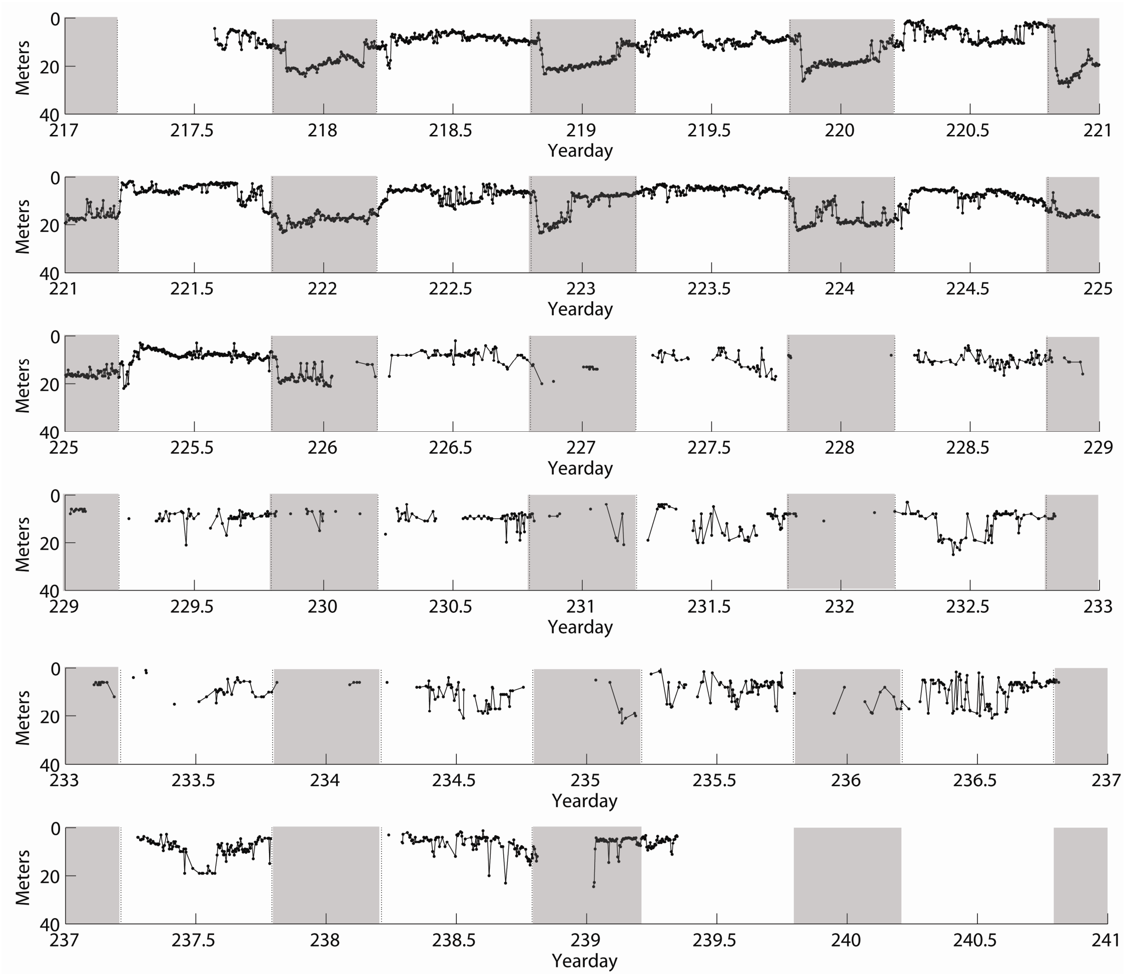

Figure G.43. The day and night vertical distribution of Fish 34300 in 2005 are represented with the shaded bars indicating night.

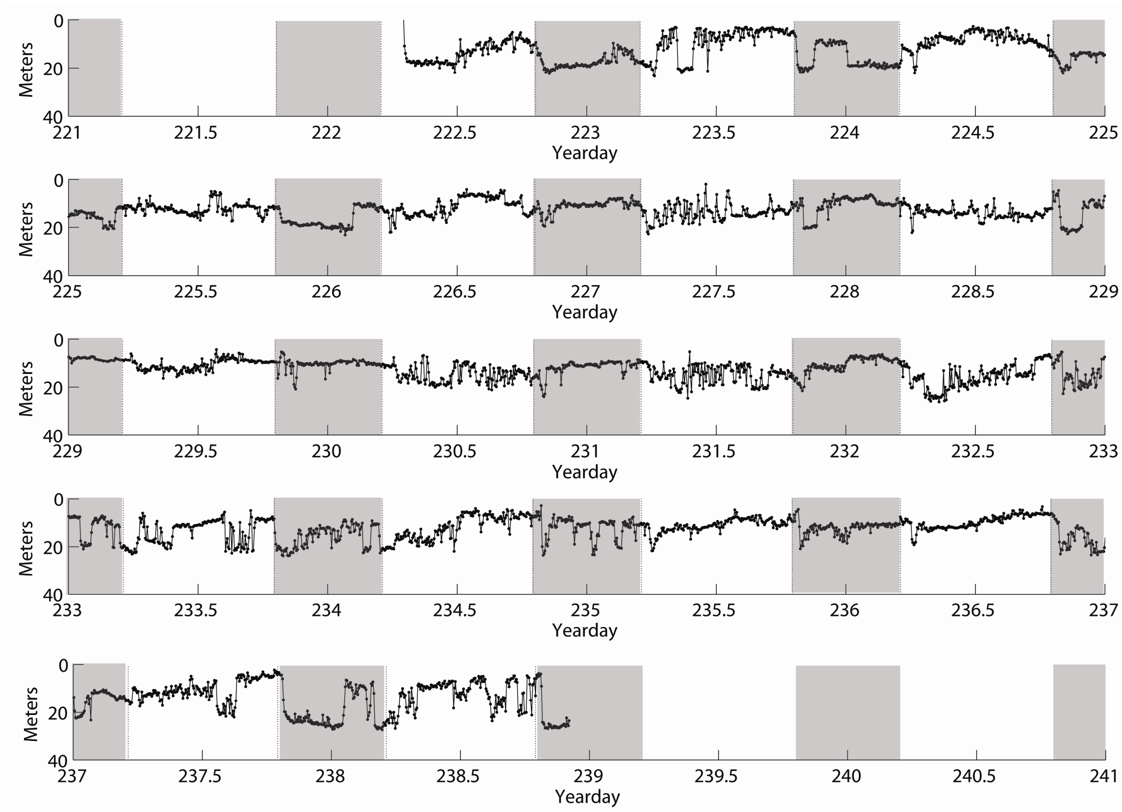

Figure G.44. The day and night vertical distribution of Fish 34600 in 2005 are represented with the shaded bars indicating night.

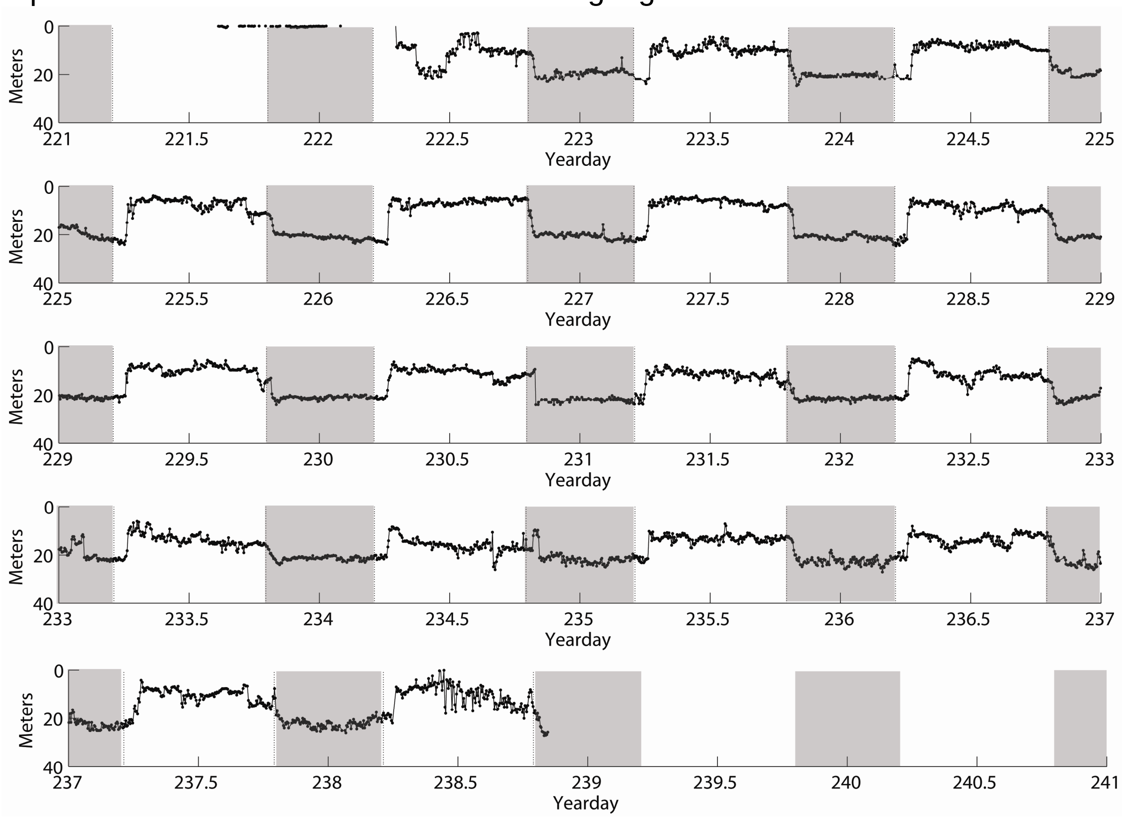

Figure G.45. The day and night vertical distribution of Fish 34800 in 2005 are represented with the shaded bars indicating night.

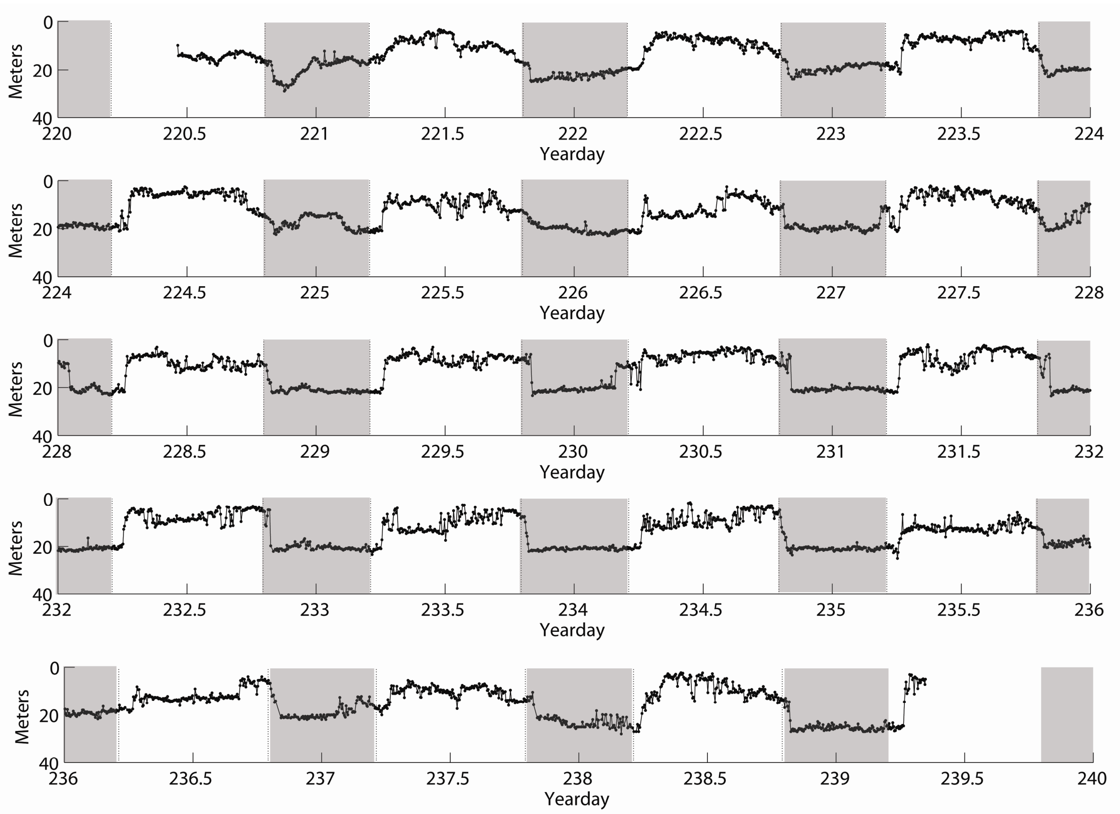

Figure G.46. The day and night vertical distribution of Fish 34900 in 2005 are represented with the shaded bars indicating night.

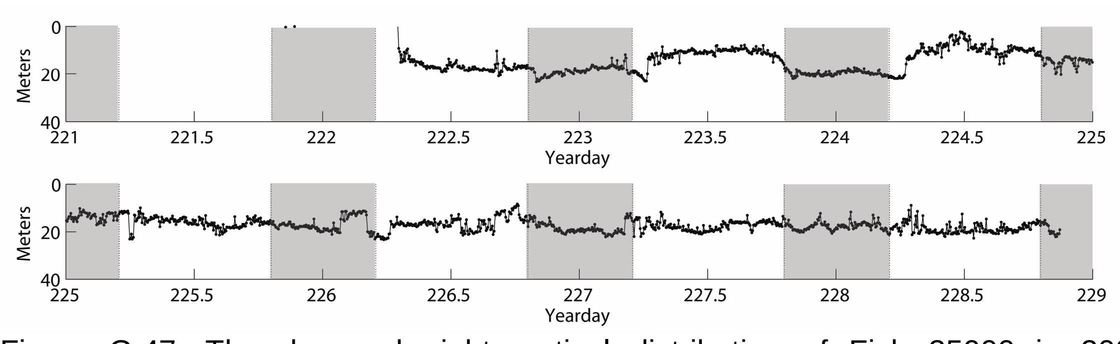

Figure G.47. The day and night vertical distribution of Fish 35000 in 2005 are represented with the shaded bars indicating night.

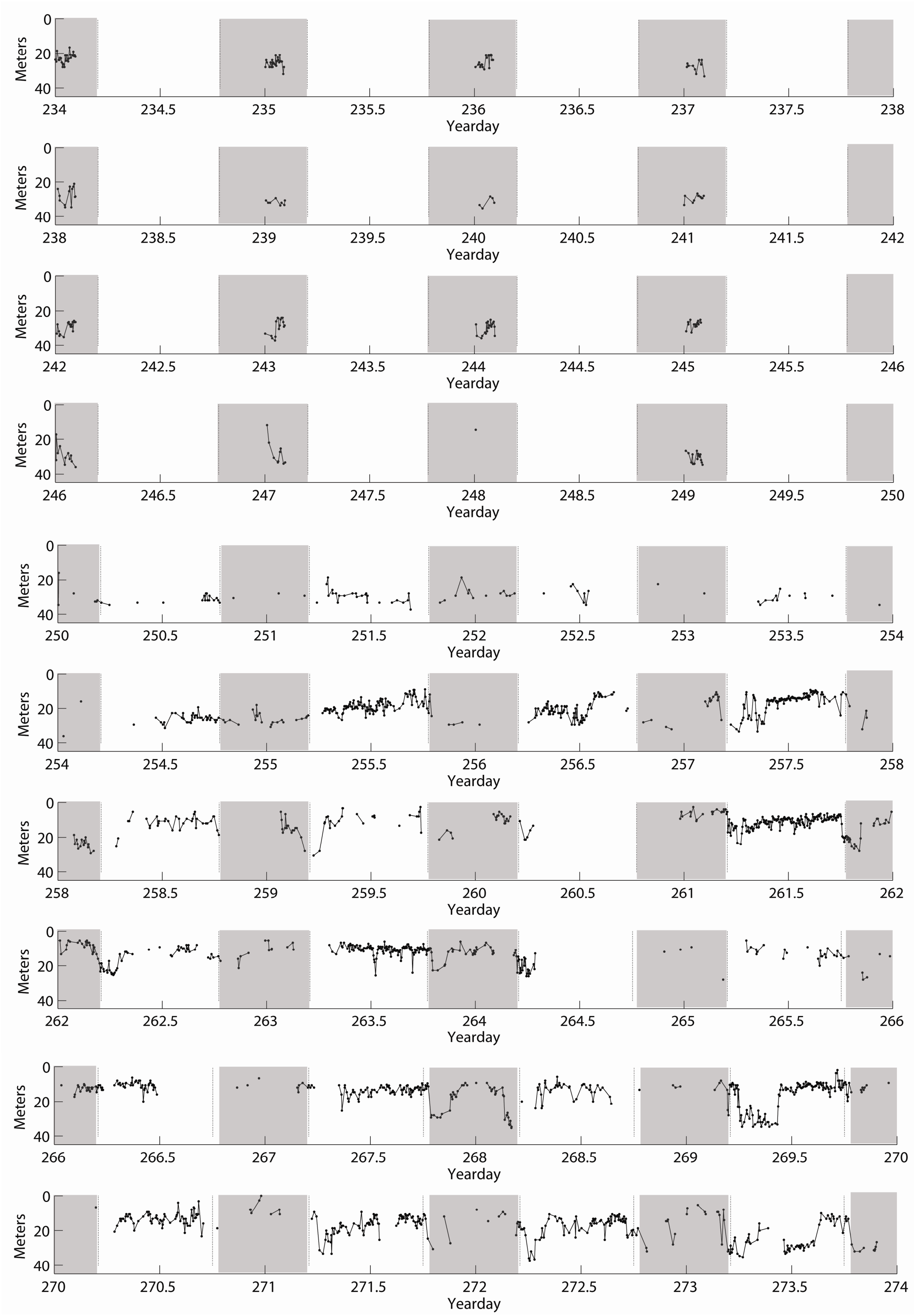

Figure G.48. The day and night vertical distribution of Fish 34800 in 2006 are represented with the shaded bars indicating night.

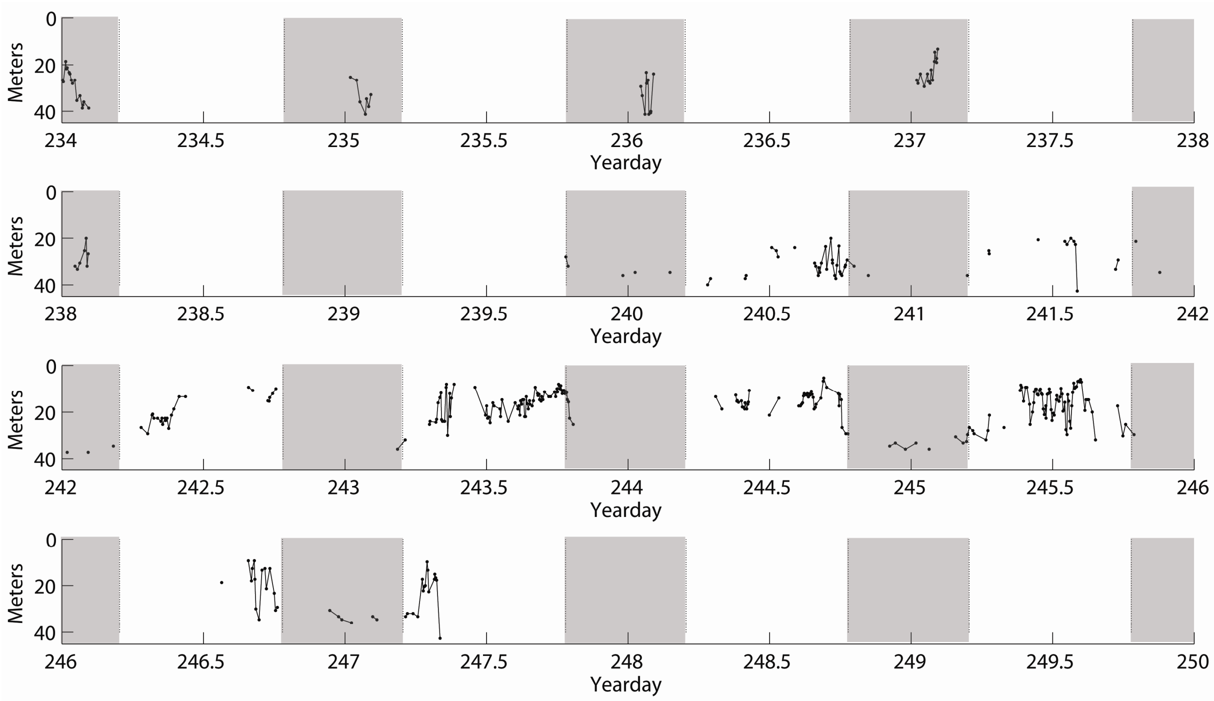

Figure G.49. The day and night vertical distribution of Fish 34900 in 2006 are represented with the shaded bars indicating night.

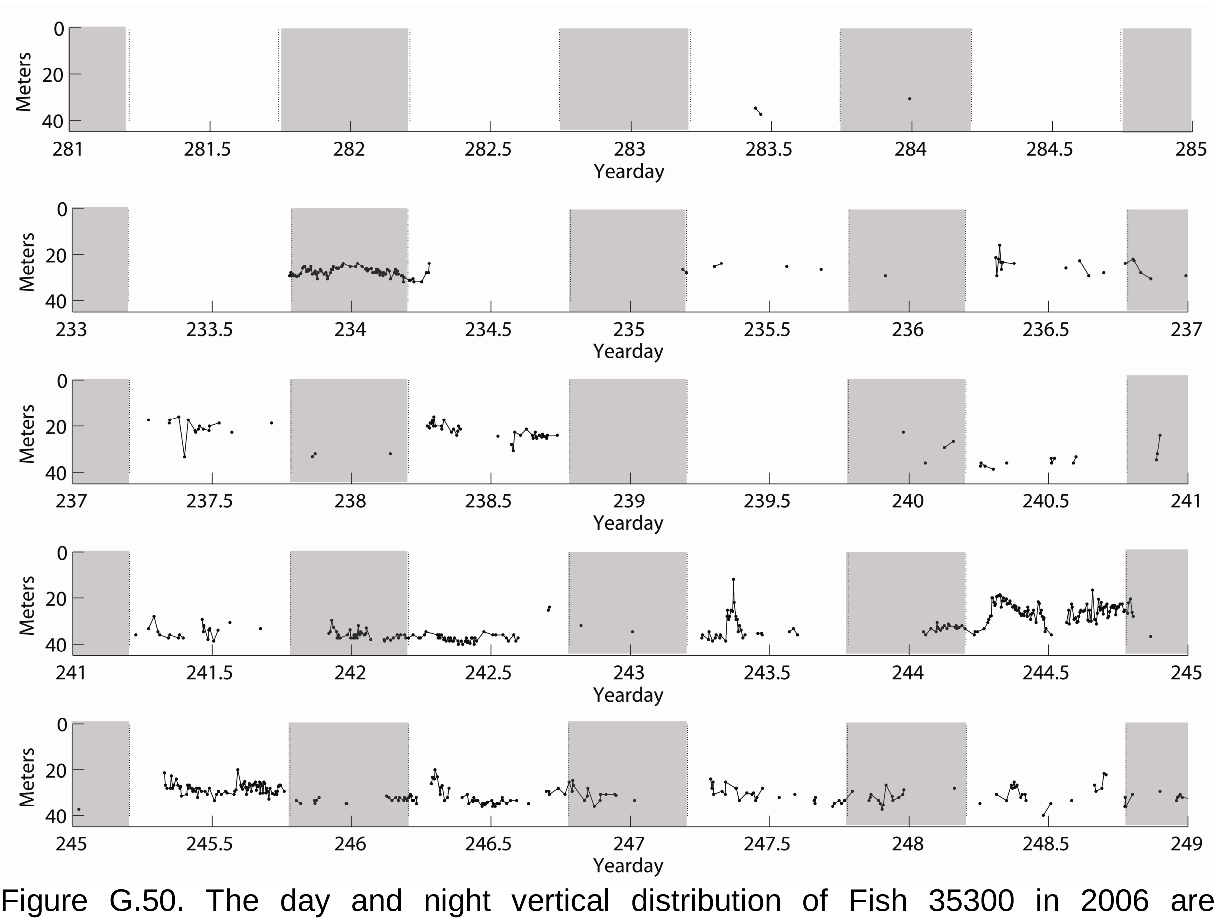

Figure G.50. The day and night vertical distribution of Fish 35300 in 2006 are represented with the shaded bars indicating night.

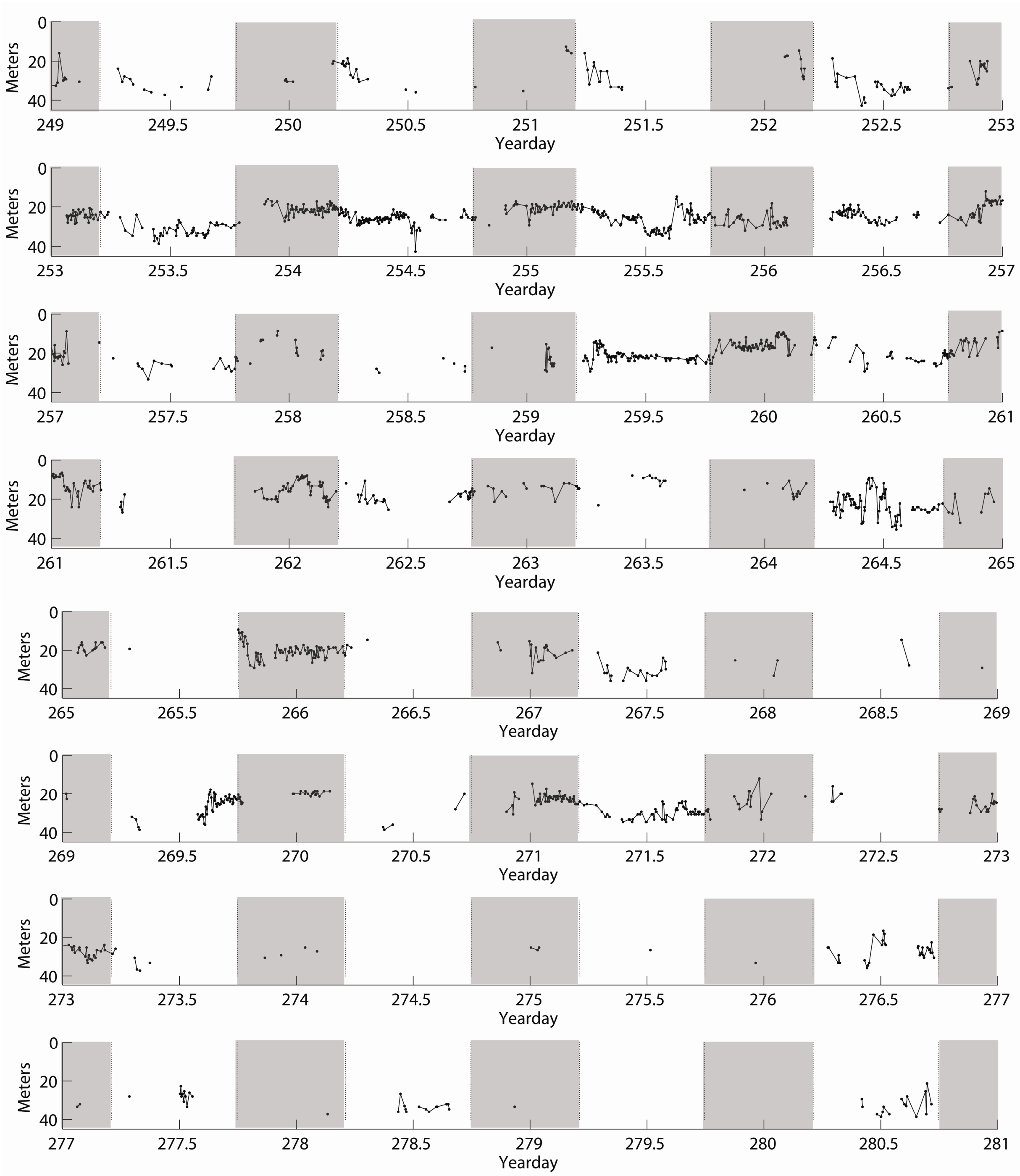

Figure G.50 (continued)

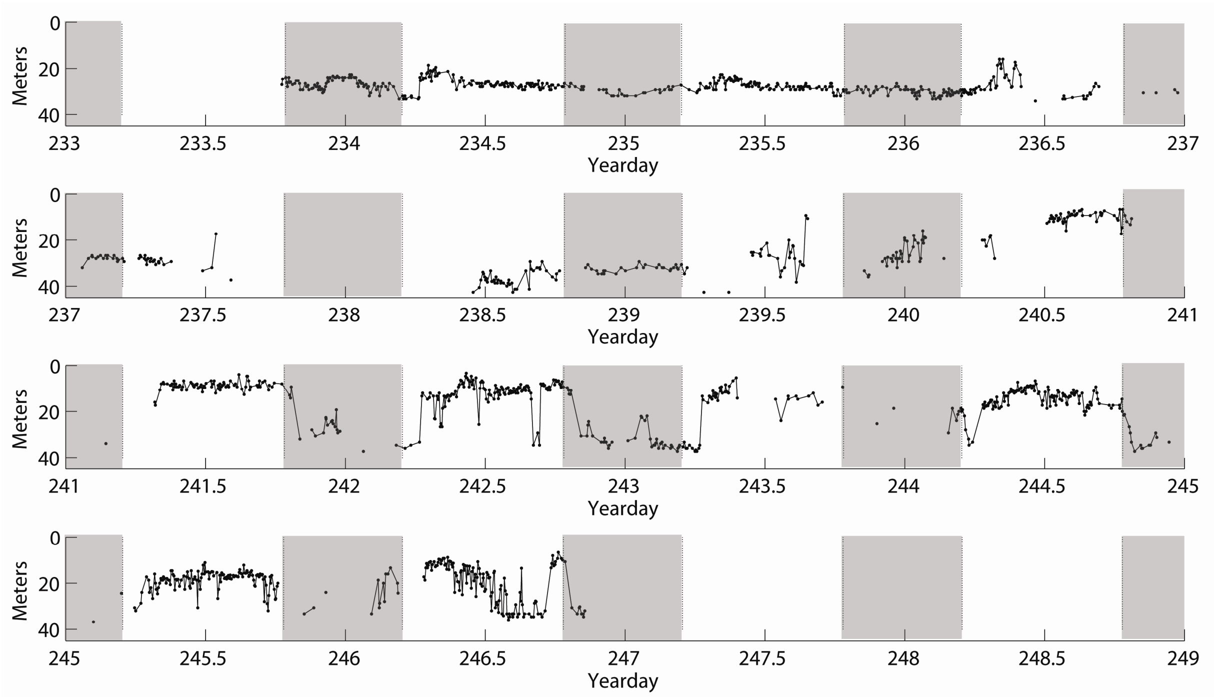

Figure G.51. The day and night vertical distribution of Fish 35600 in 2006 are represented with the shaded bars indicating night.

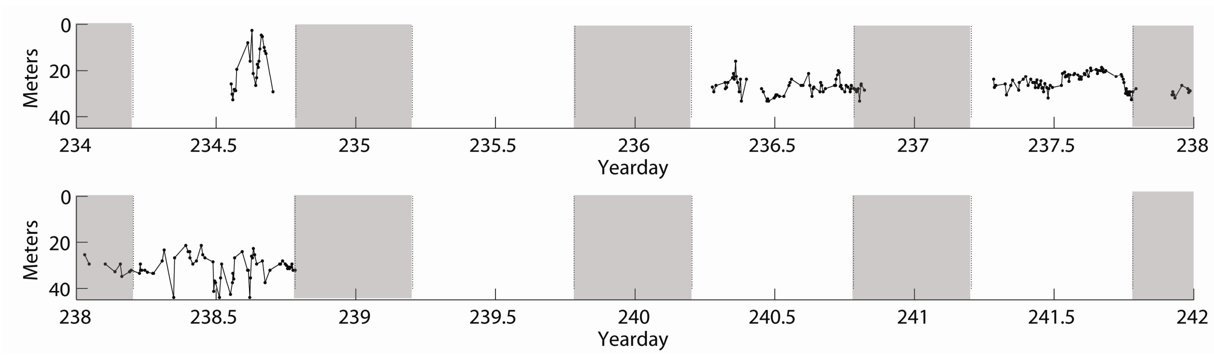

Figure G.52. The day and night vertical distribution of Fish 35700 in 2006 are represented with the shaded bars indicating night.

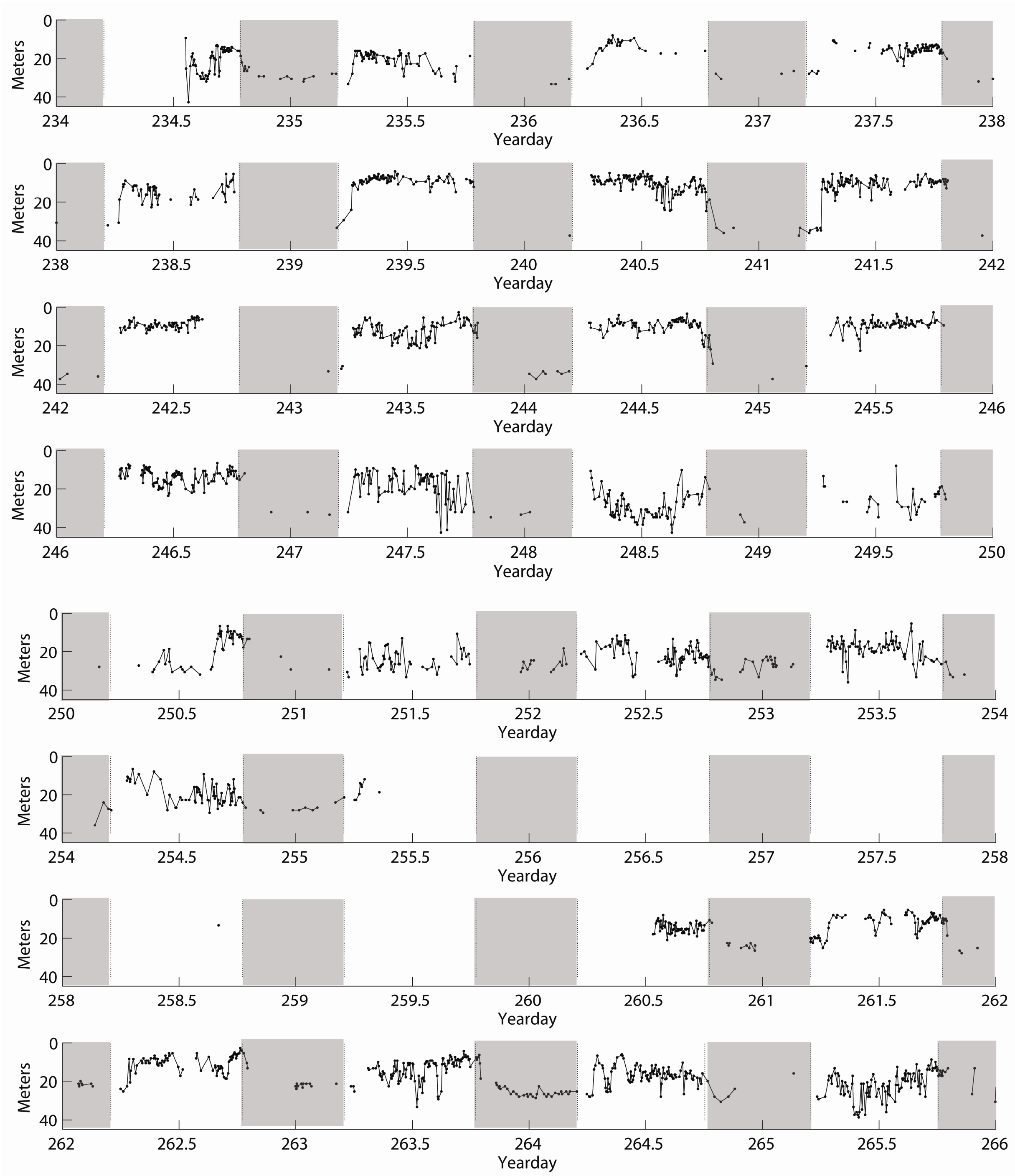

Figure G.53. The day and night vertical distribution of Fish 35900 in 2006 are represented with the shaded bars indicating night.

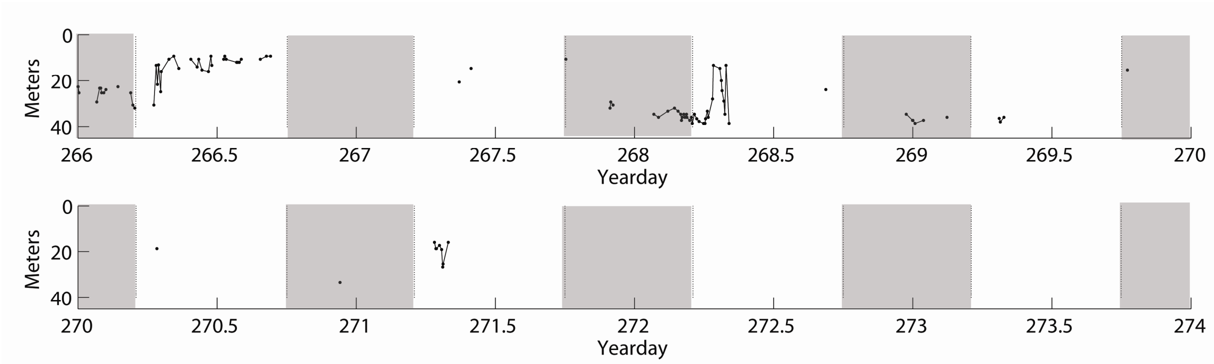

Figure G.53 (continued)

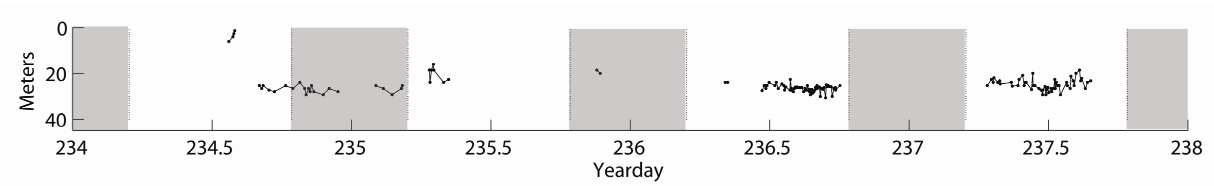

Figure G.54. The day and night vertical distribution of Fish 36100 in 2006 are represented with the shaded bars indicating night.

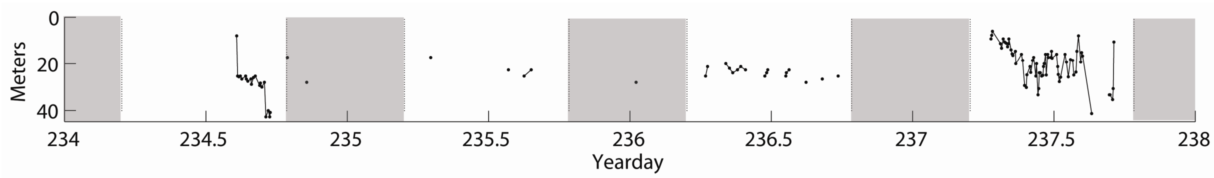

Figure G.55. The day and night vertical distribution of Fish 36400 in 2006 are represented with the shaded bars indicating night.

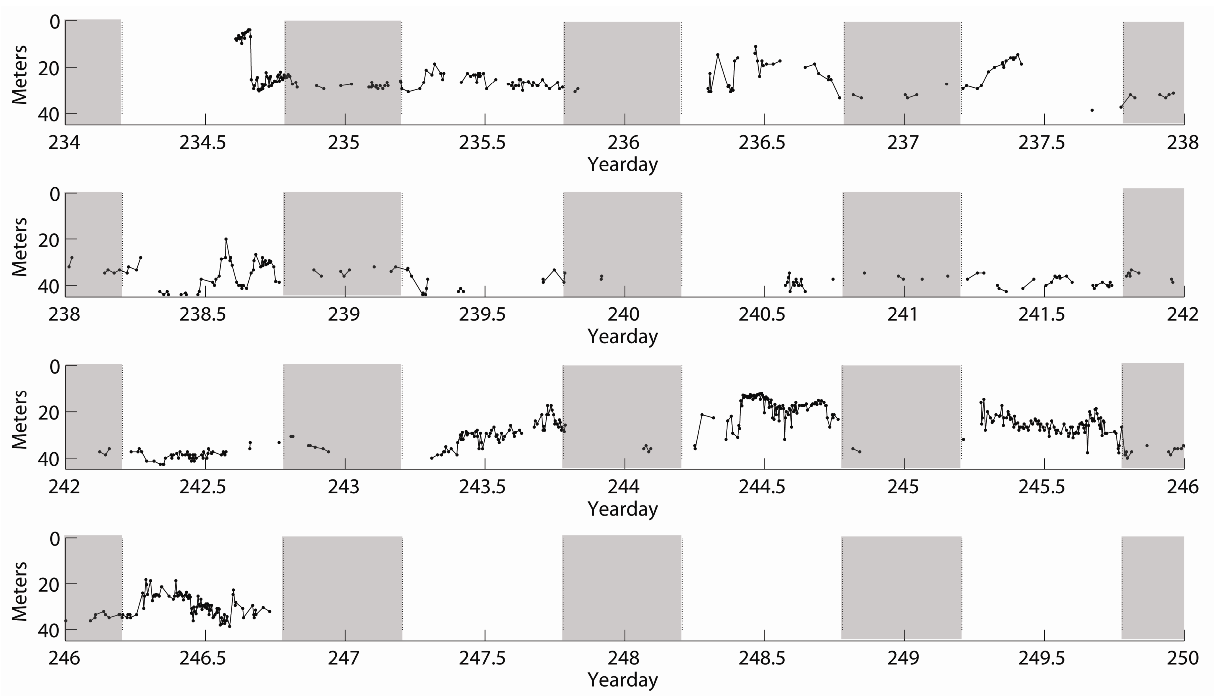

Figure G.56. The day and night vertical distribution of Fish 36500 in 2006 are represented with the shaded bars indicating night.

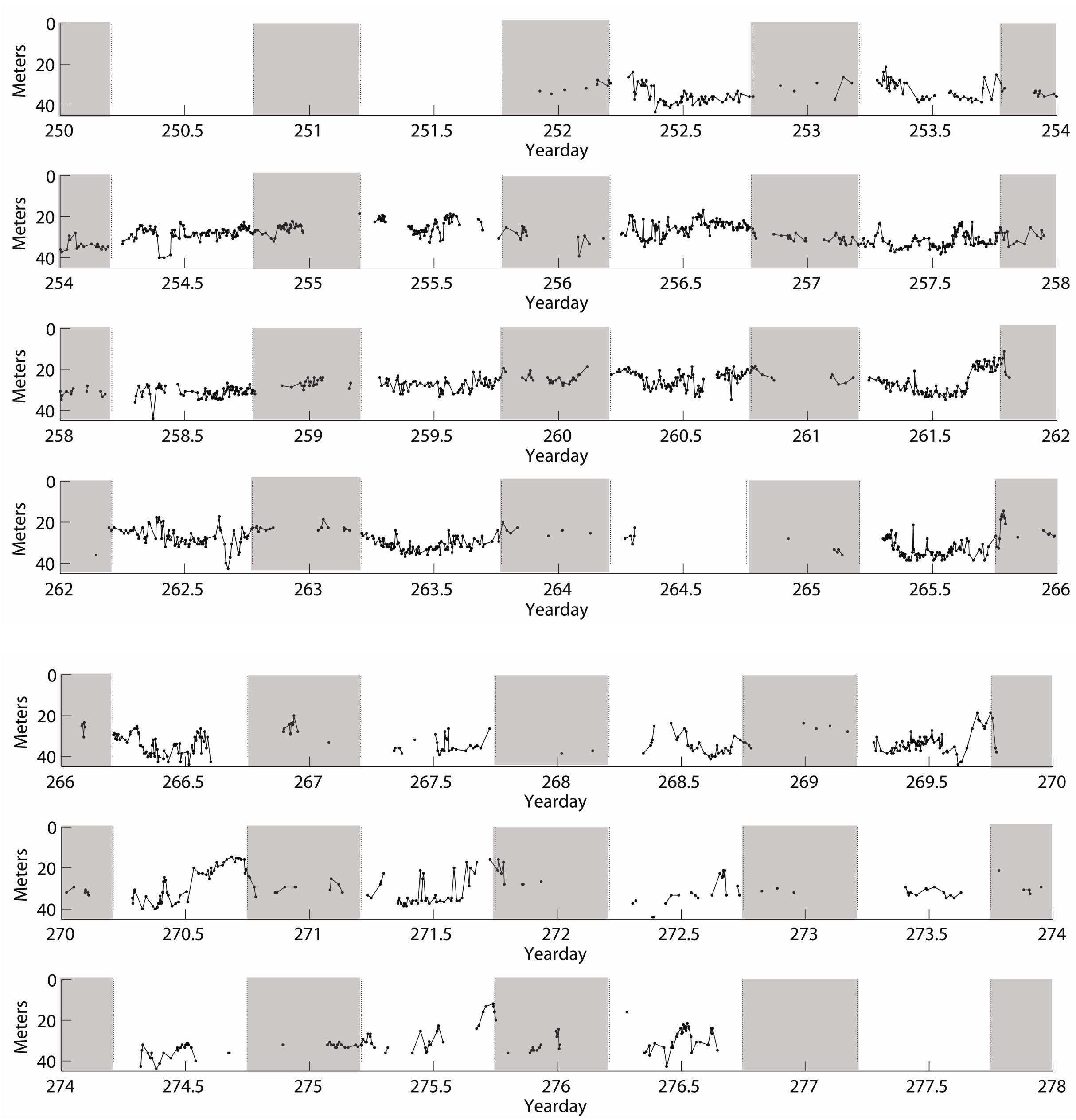

Figure G.56 (continued)

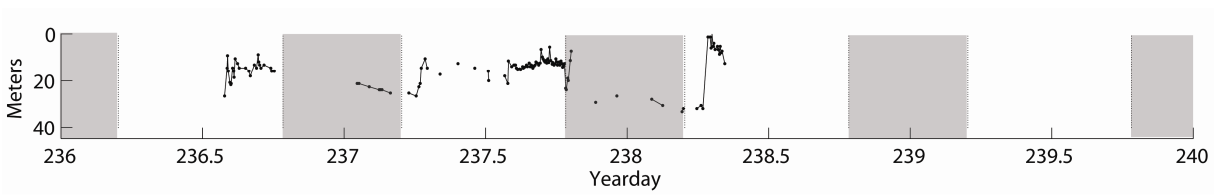

Figure G.57. The day and night vertical distribution of Fish 36800 in 2006 are represented with the shaded bars indicating night.

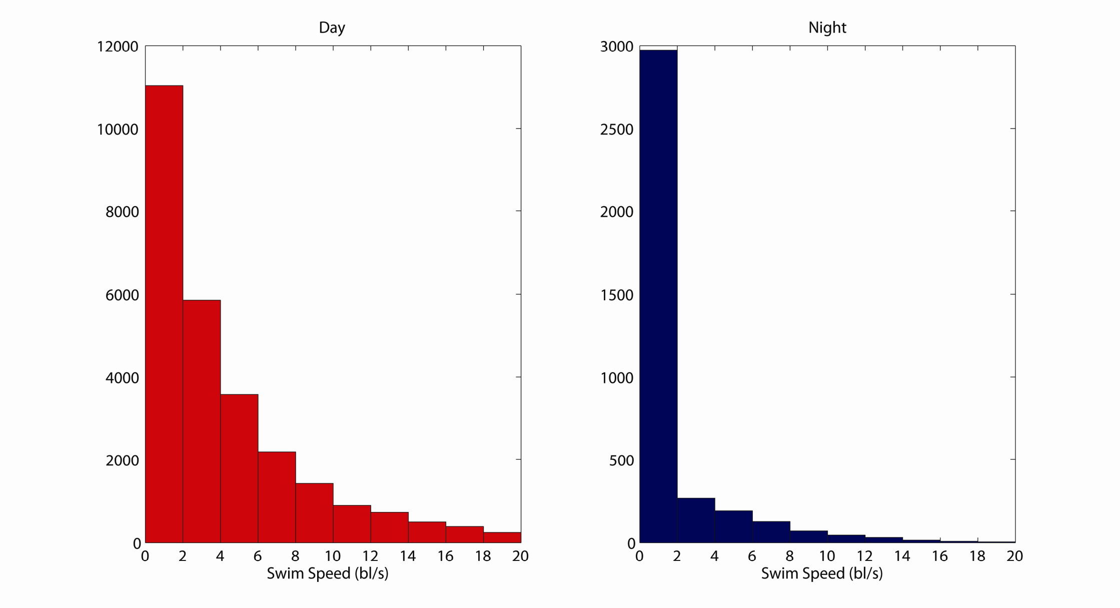

Figure G.58. The daytime and nighttime swimming speeds (body lengths/second) of Fish 29500 are plotted over the course of the study period (August 10 – 21, 2005).

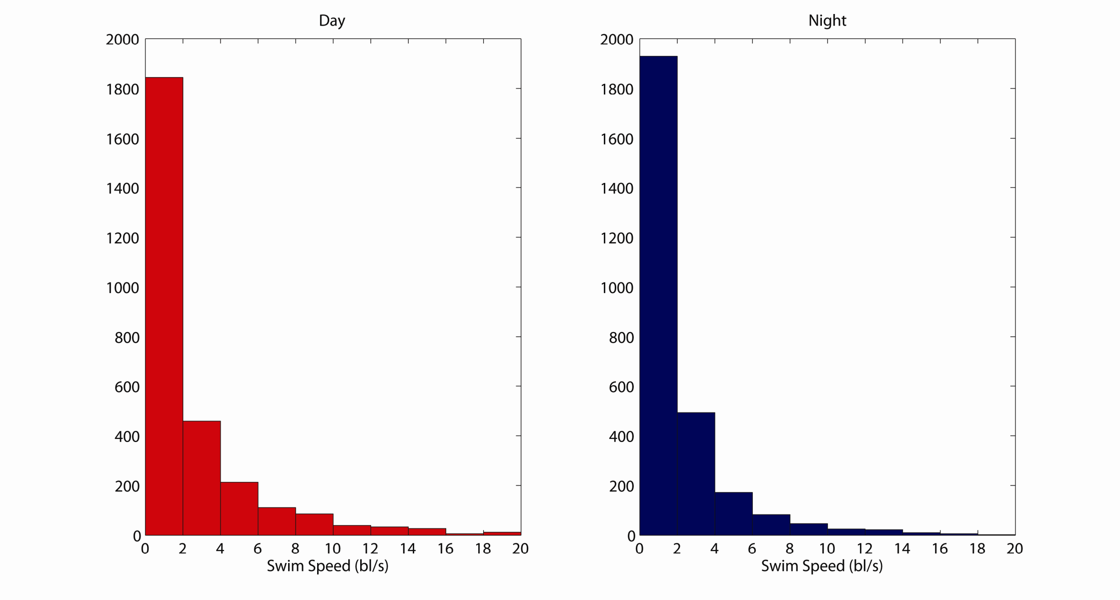

Figure G.59. The daytime and nighttime swimming speeds (body lengths/second) of Fish 30100 are plotted over the course of the study period (August 12 – 13, 2005).

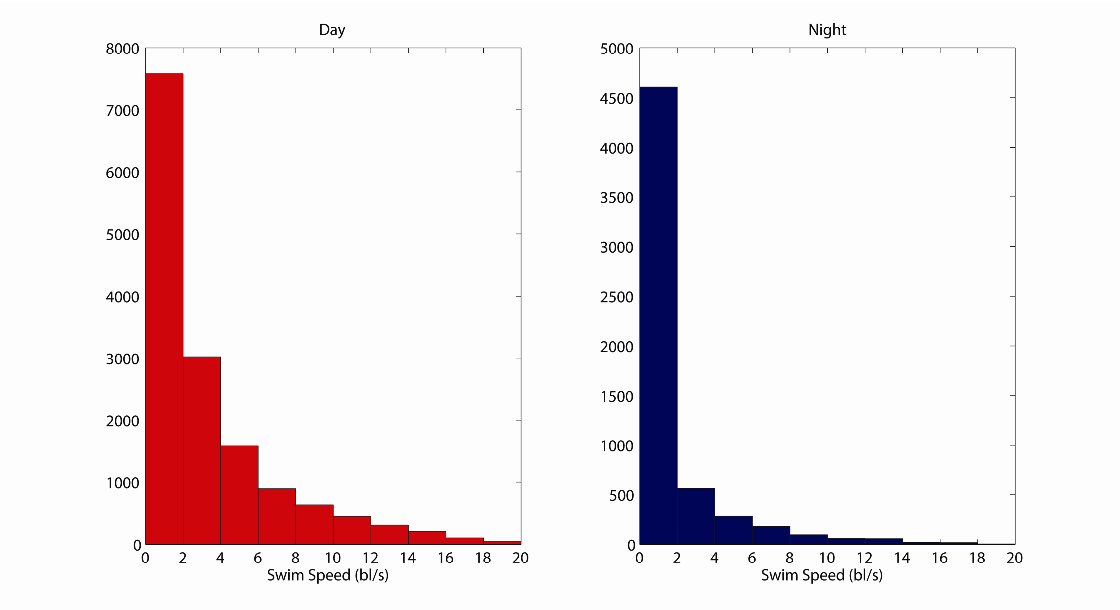

Figure G.60. The daytime and nighttime swimming speeds (body lengths/second) of Fish 30200 are plotted over the course of the study period (August 10 – 25, 2005).

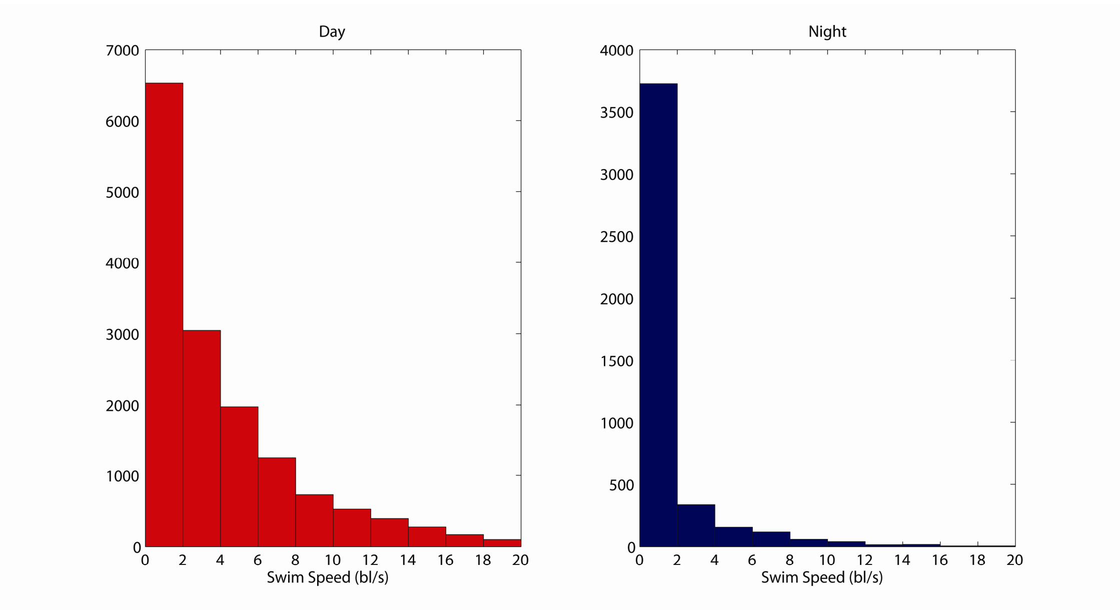

Figure G.61. The daytime and nighttime swimming speeds (body lengths/second) of Fish 30500 are plotted over the course of the study period (August 13 – 27, 2005).

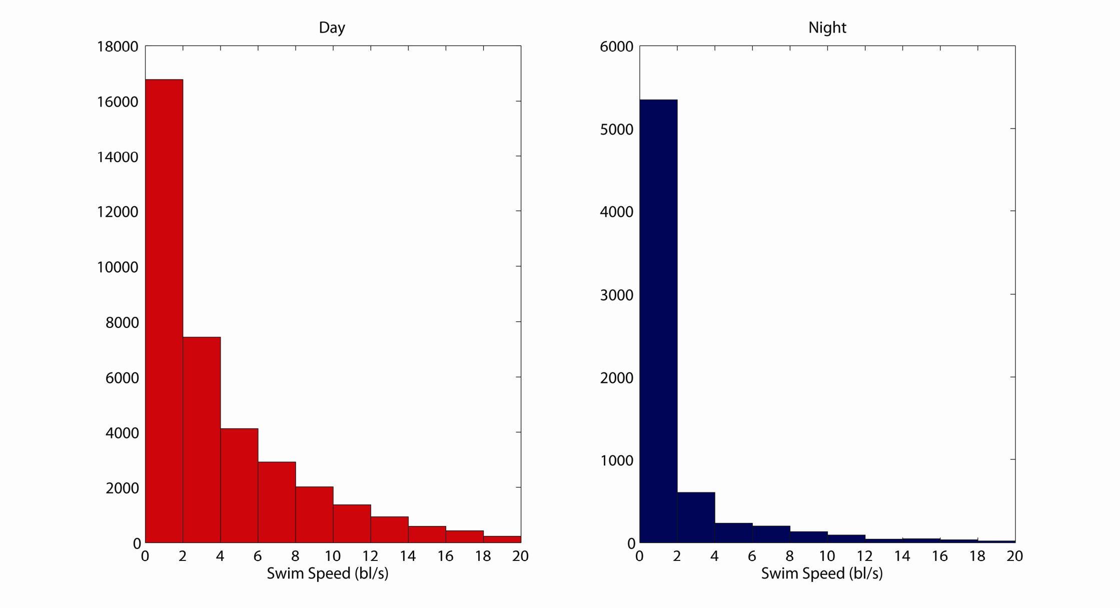

Figure G.62. The daytime and nighttime swimming speeds (body lengths/second) of Fish 30600 are plotted over the course of the study period (August 13 – 27, 2005).

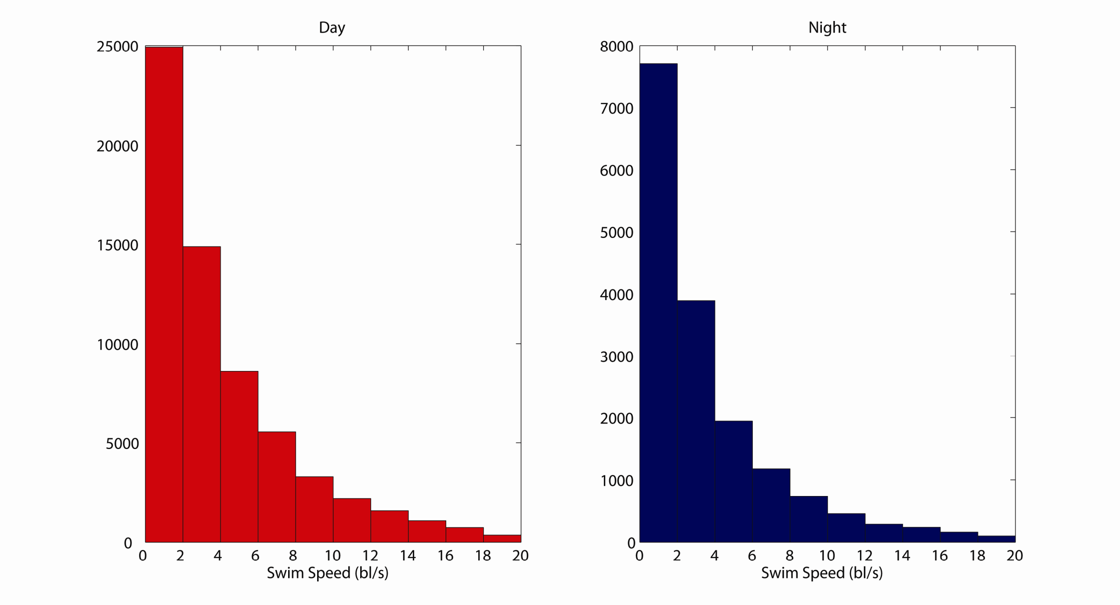

Figure G.63. The daytime and nighttime swimming speeds (body lengths/second) of Fish 30800 are plotted over the course of the study period (August 13 – 24, 2005).

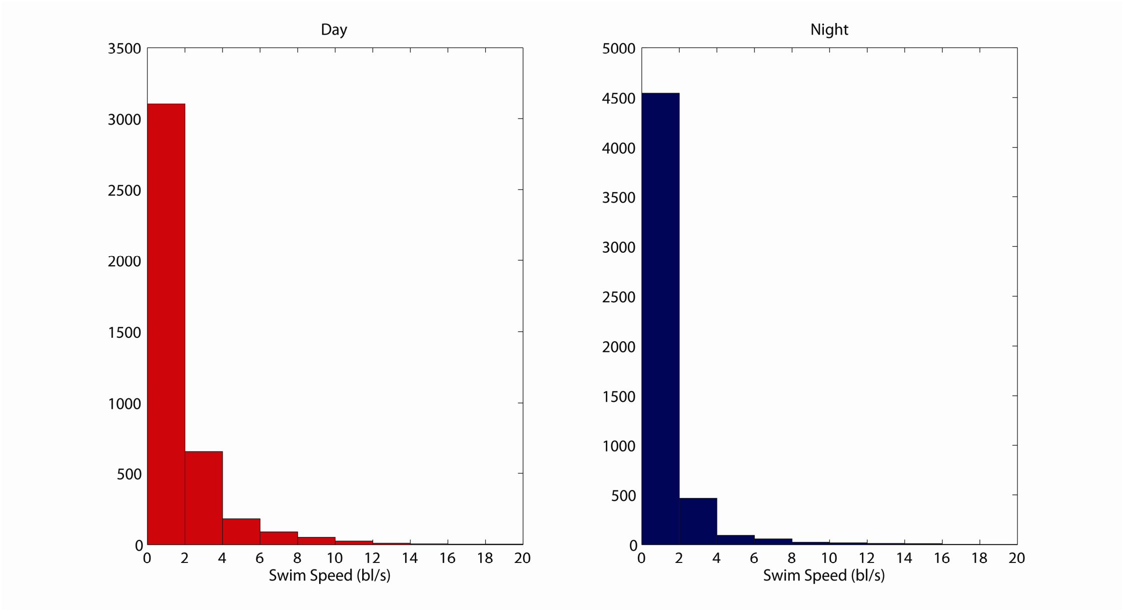

Figure G.64. The daytime and nighttime swimming speeds (body lengths/second) of Fish 31200 are plotted over the course of the study period (August 7 – 8, 2005).

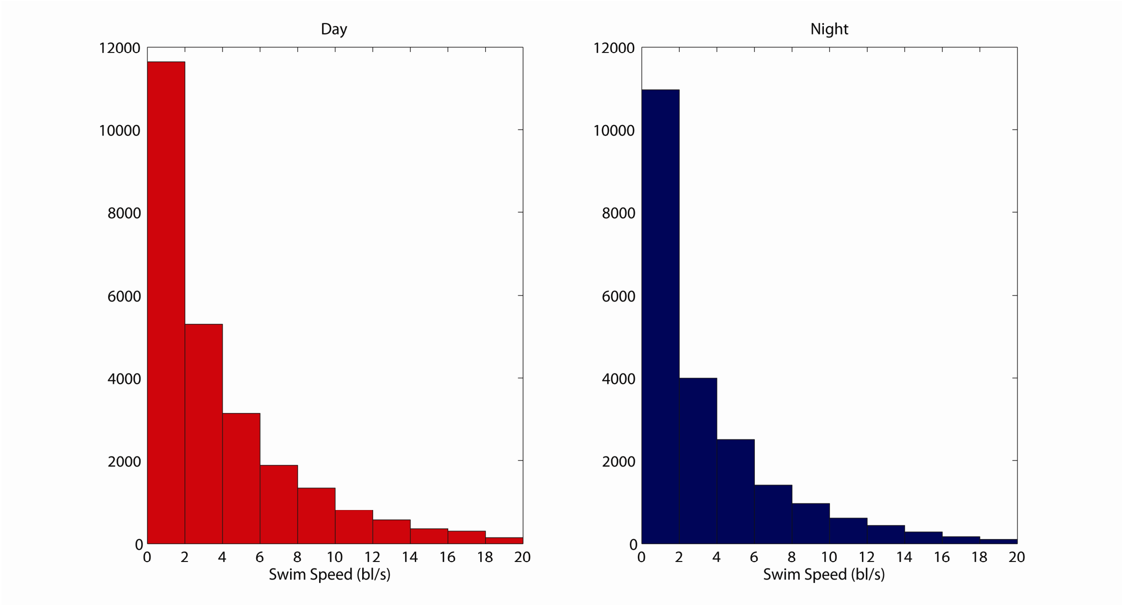

Figure G.65. The daytime and nighttime swimming speeds (body lengths/second) of Fish 31300 are plotted over the course of the study period (August 8 – 27, 2005).

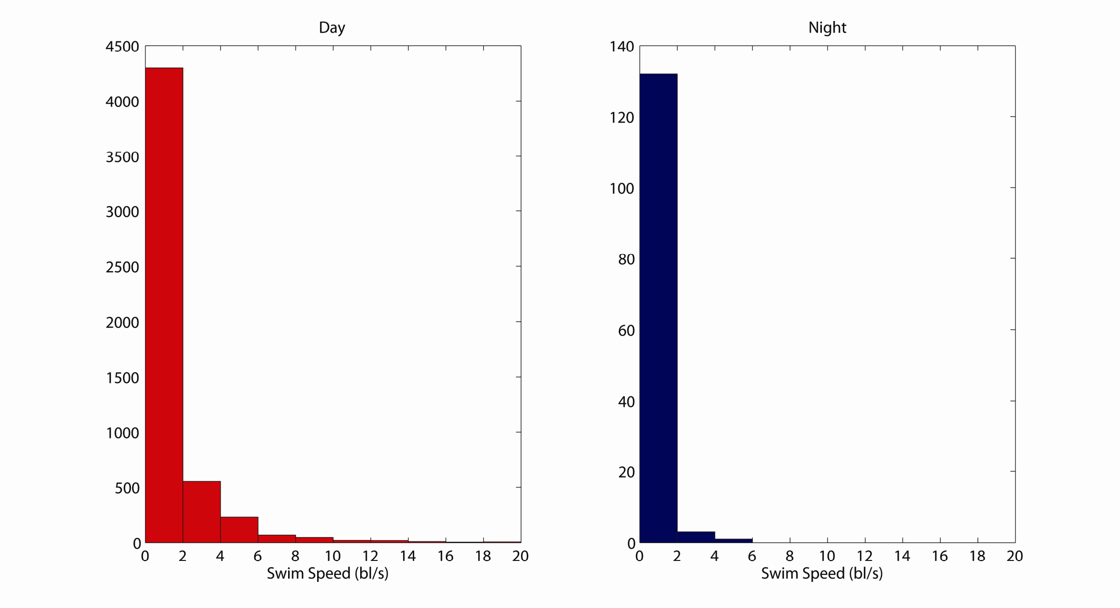

Figure G.66. The daytime and nighttime swimming speeds (body lengths/second) of Fish 31400 are plotted over the course of the study period (August 9 – 13, 2005).

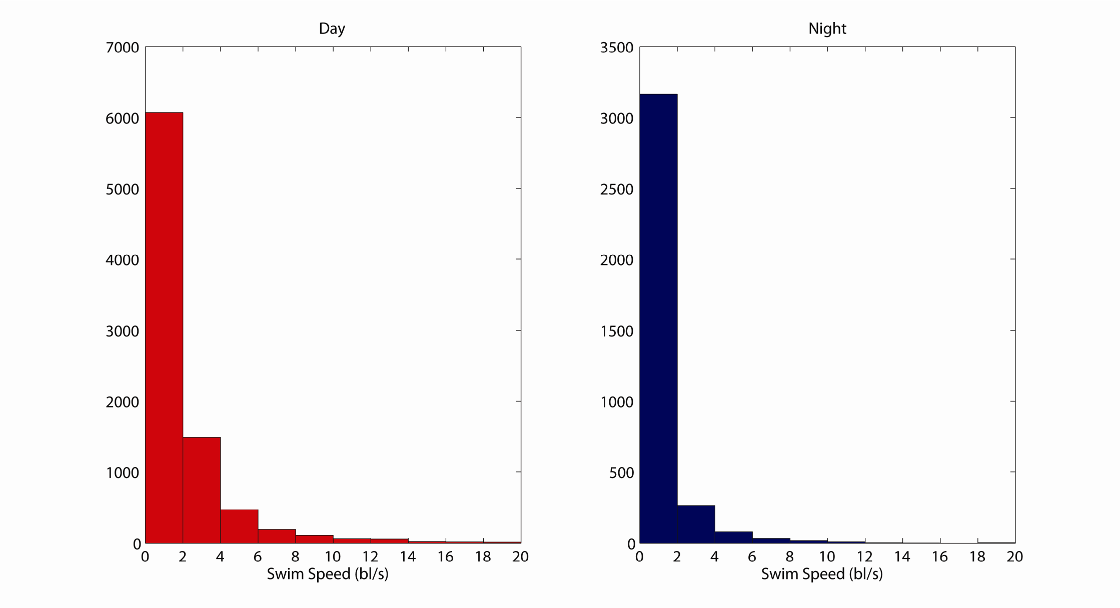

Figure G.67. The daytime and nighttime swimming speeds (body lengths/second) of Fish 31500 are plotted over the course of the study period (August 9 – 13, 2005).

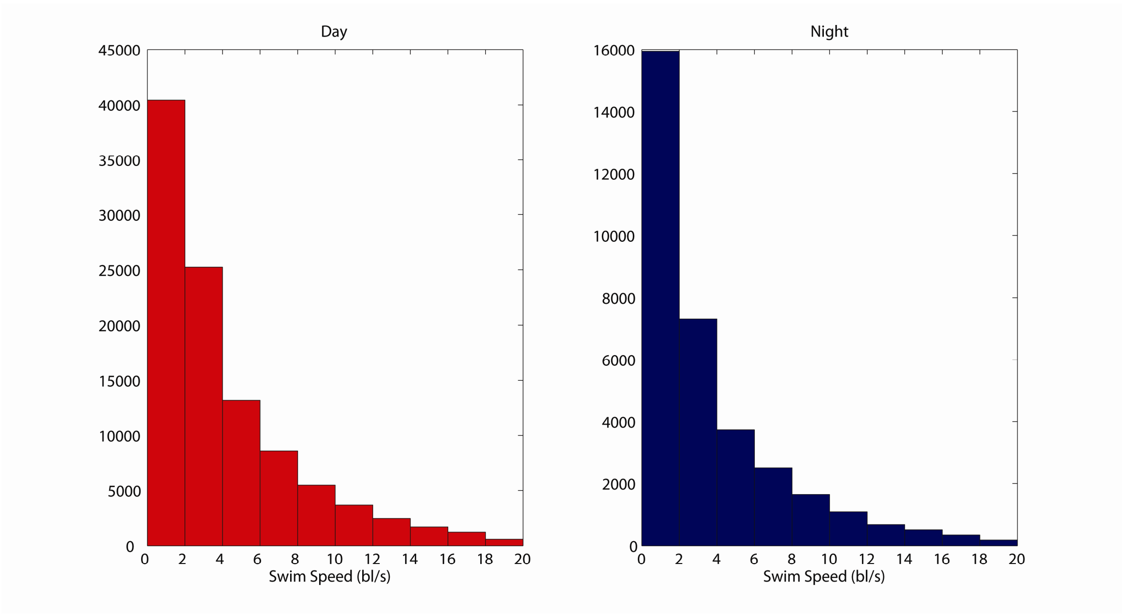

Figure G.68. The daytime and nighttime swimming speeds (body lengths/second) of Fish 31800 are plotted over the course of the study period (August 8 – 27, 2005).

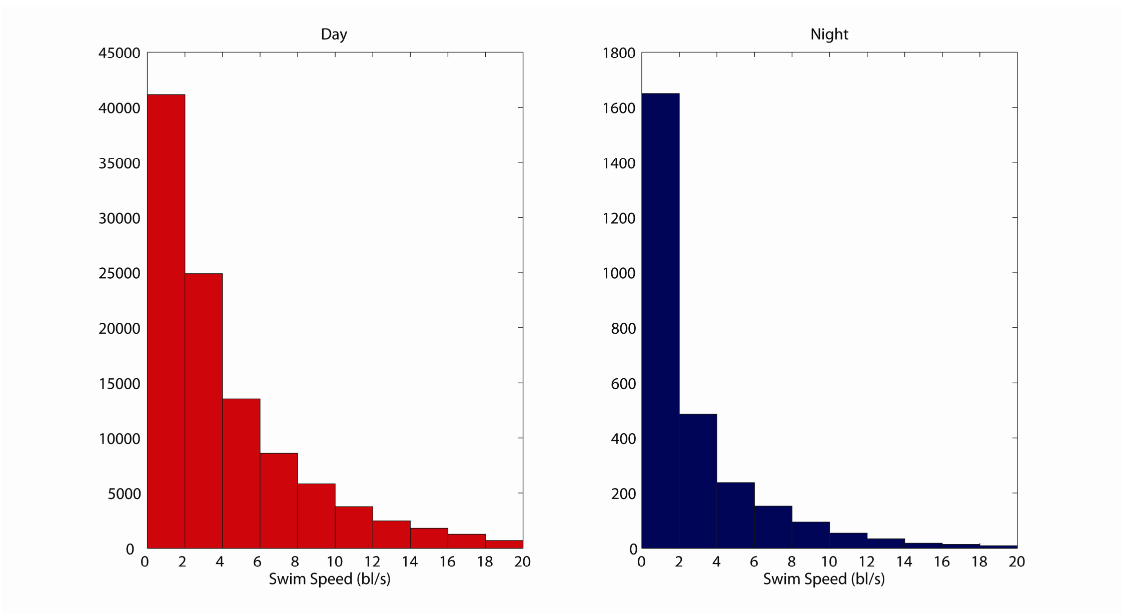

Figure G.69. The daytime and nighttime swimming speeds (body lengths/second) of Fish 32100 are plotted over the course of the study period (August 9 – 27, 2005).

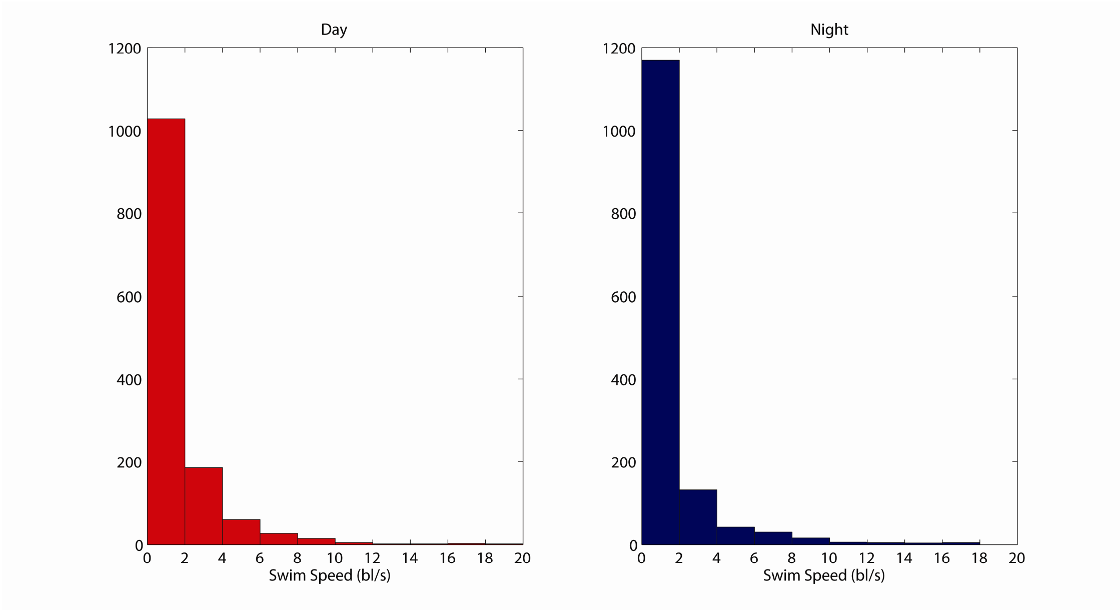

Figure G.70. The daytime and nighttime swimming speeds (body lengths/second) of Fish 32300 are plotted over the course of the study period (August 7 – 10, 2005).

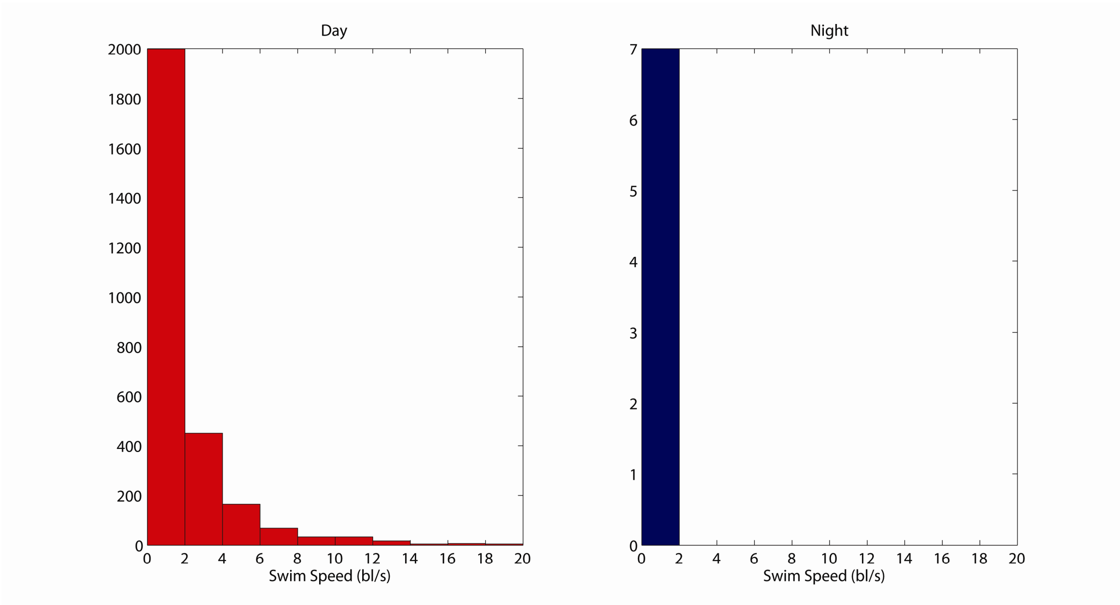

Figure G.71. The daytime and nighttime swimming speeds (body lengths/second) of Fish 32400 are plotted over the course of the study period (August 6 – 8, 2005).

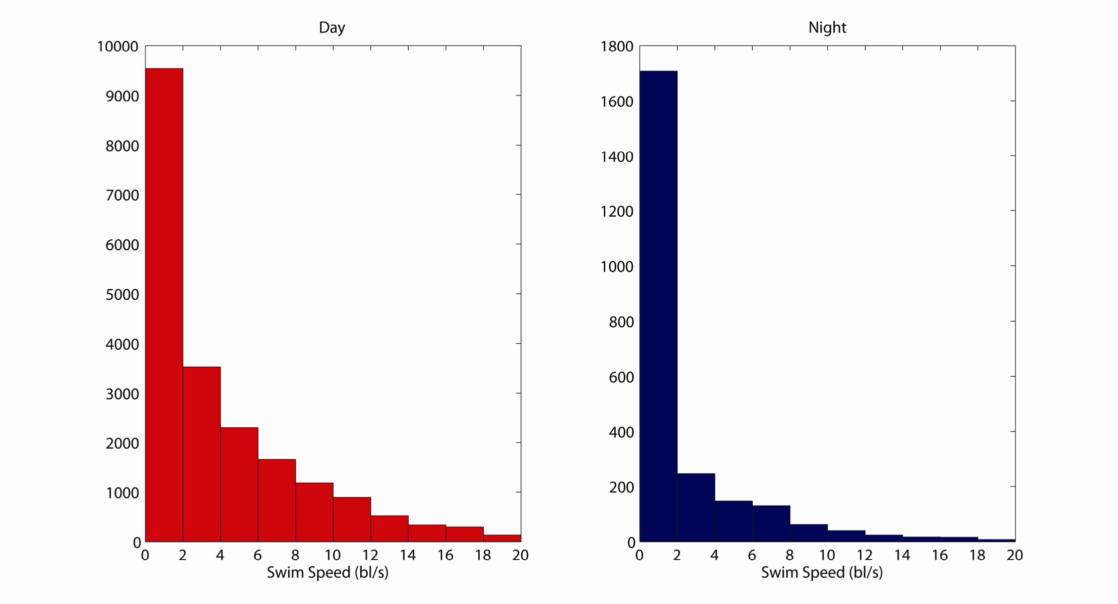

Figure G.72. The daytime and nighttime swimming speeds (body lengths/second) of Fish 32500 are plotted over the course of the study period (August 8 – 27, 2005).

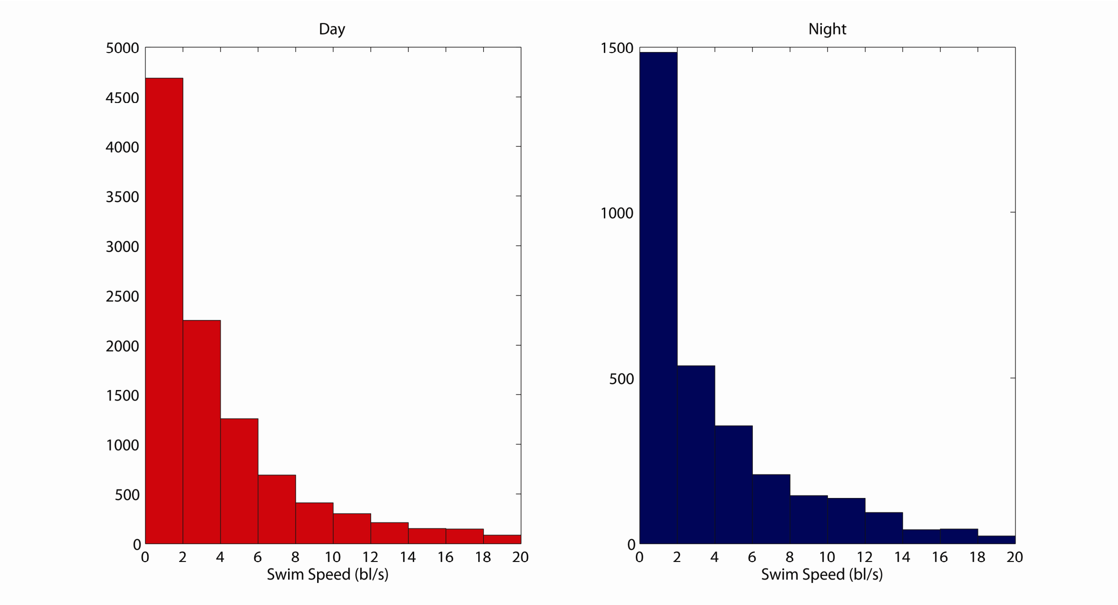

Figure G.73. The daytime and nighttime swimming speeds (body lengths/second) of Fish 32700 are plotted over the course of the study period (August 8 – 26, 2005).

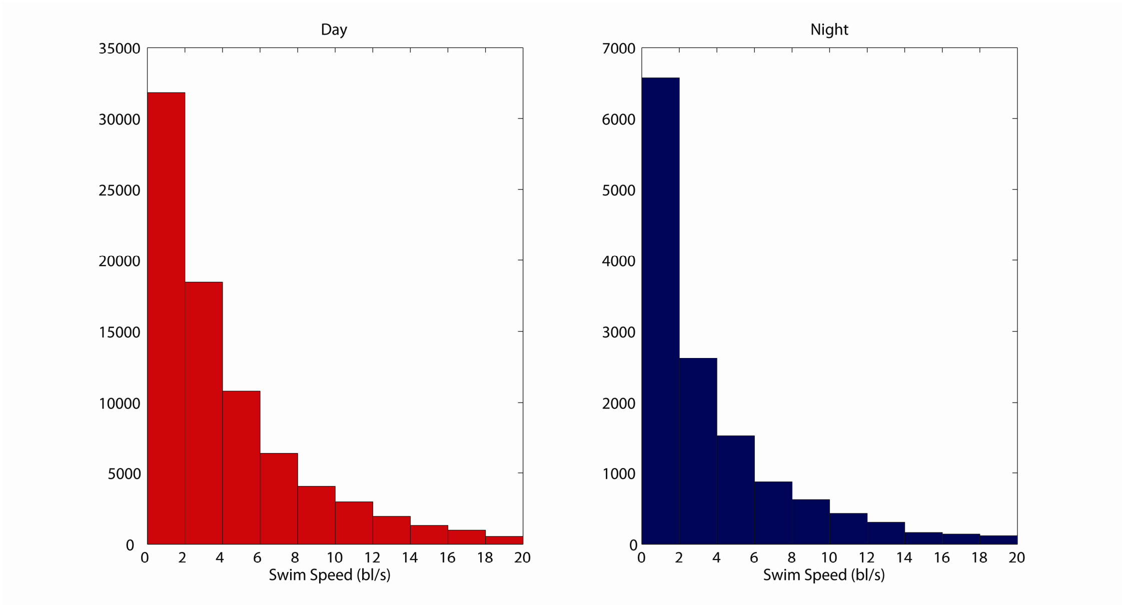

Figure G.74. The daytime and nighttime swimming speeds (body lengths/second) of Fish 32900 are plotted over the course of the study period (August 10 – 27, 2005).

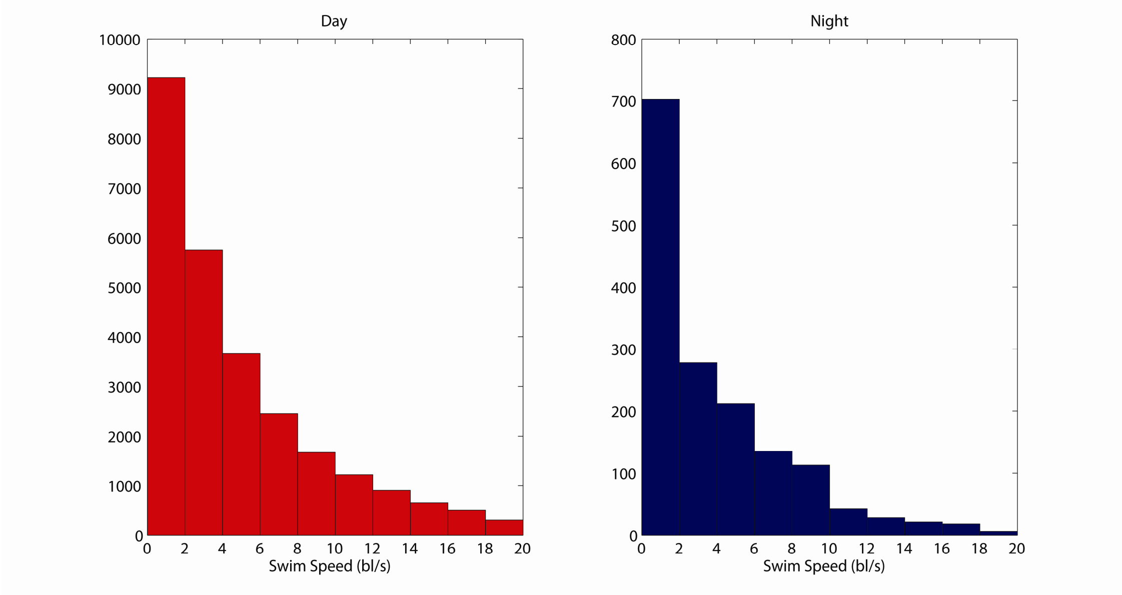

Figure G.75. The daytime and nighttime swimming speeds (body lengths/second) of Fish 33000 are plotted over the course of the study period (August 8 – 26, 2005).

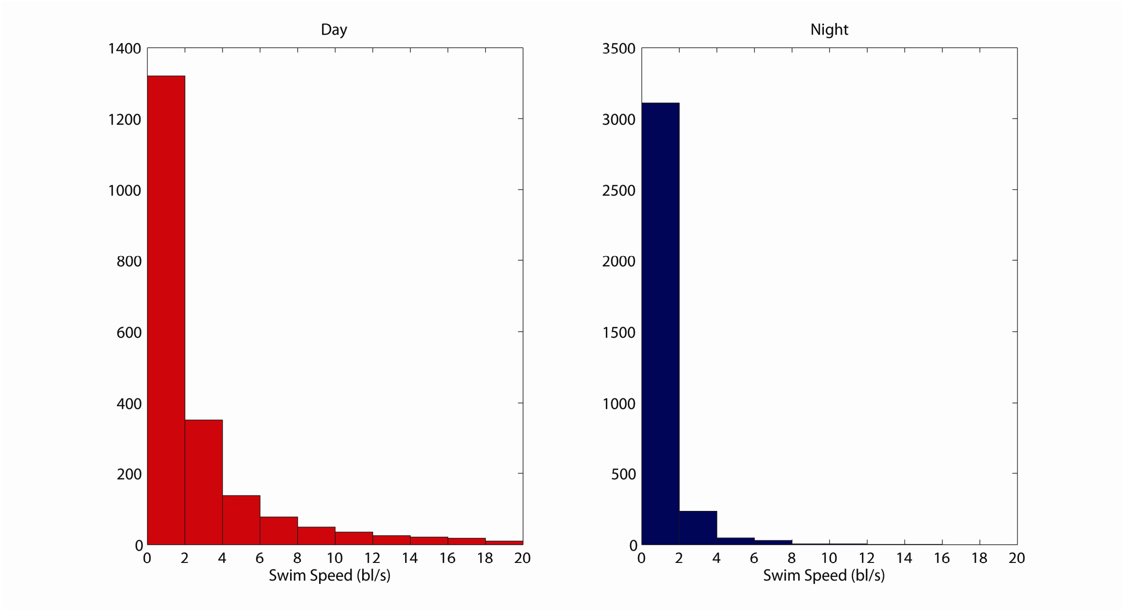

Figure G.76. The daytime and nighttime swimming speeds (body lengths/second) of Fish 33200 are plotted over the course of the study period (August 8 – 11, 2005).

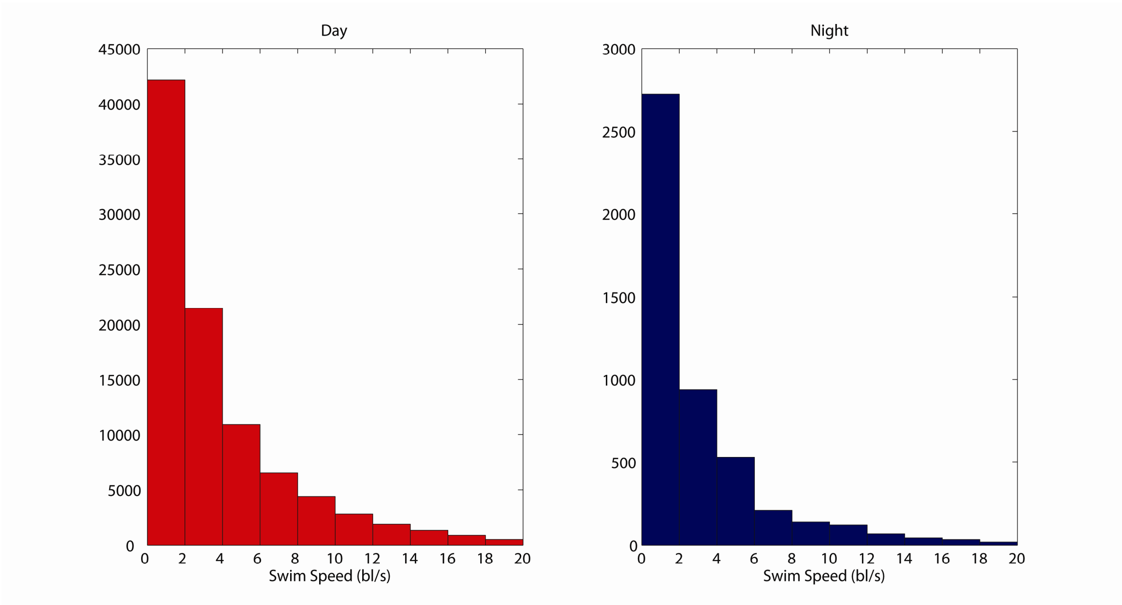

Figure G.77. The daytime and nighttime swimming speeds (body lengths/second) of Fish 33300 are plotted over the course of the study period (August 8 – 27, 2005).

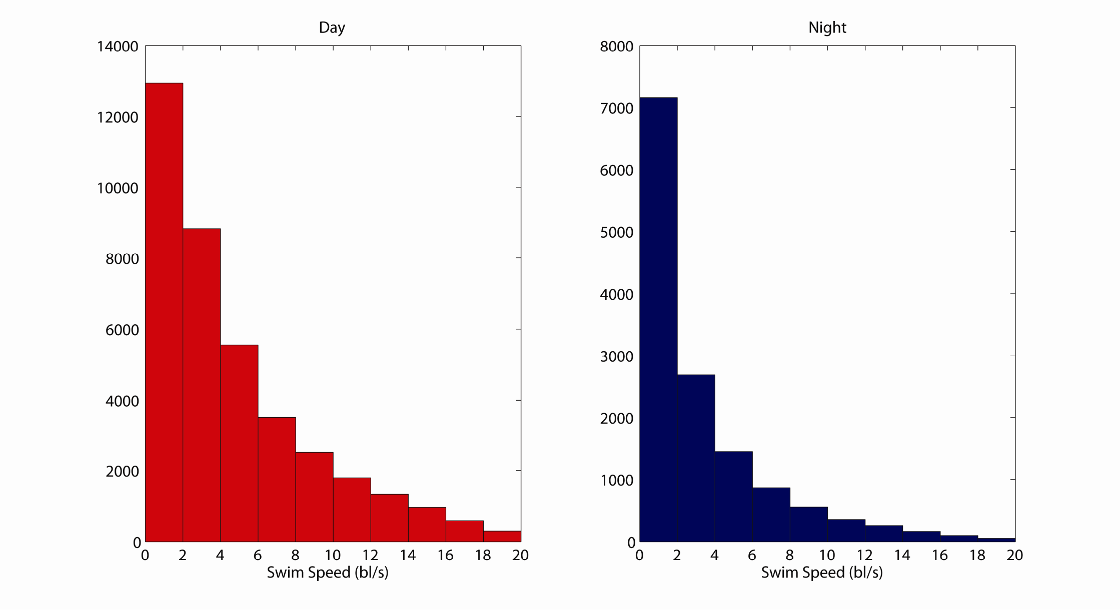

Figure G.78. The daytime and nighttime swimming speeds (body lengths/second) of Fish 33500 are plotted over the course of the study period (August 9 – 21, 2005).

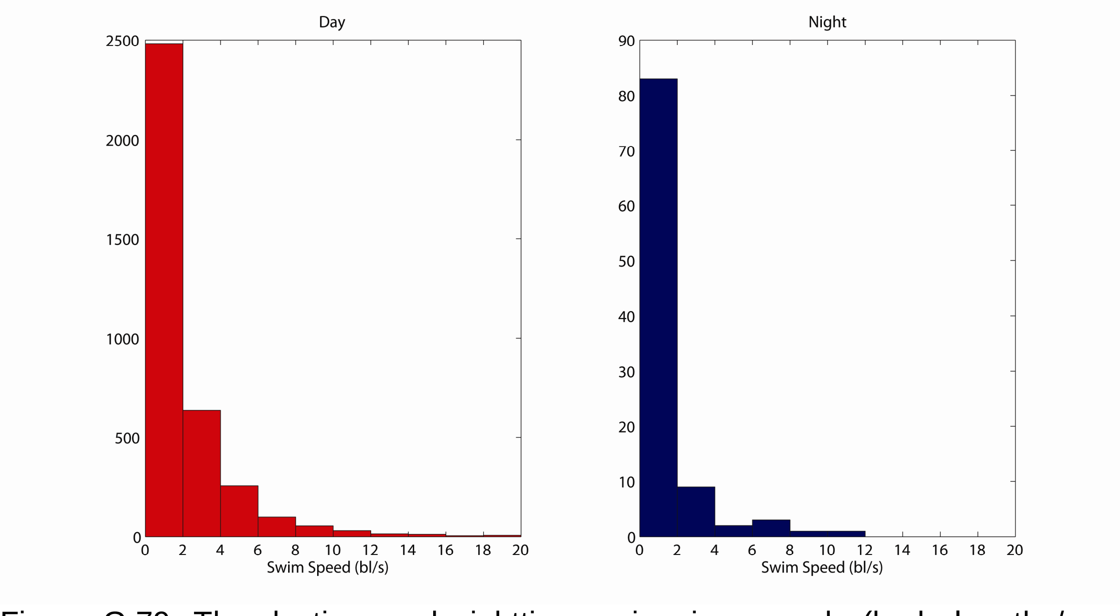

Figure G.79. The daytime and nighttime swimming speeds (body lengths/second) of Fish 33600 are plotted over the course of the study period (August 10 – 12, 2005).

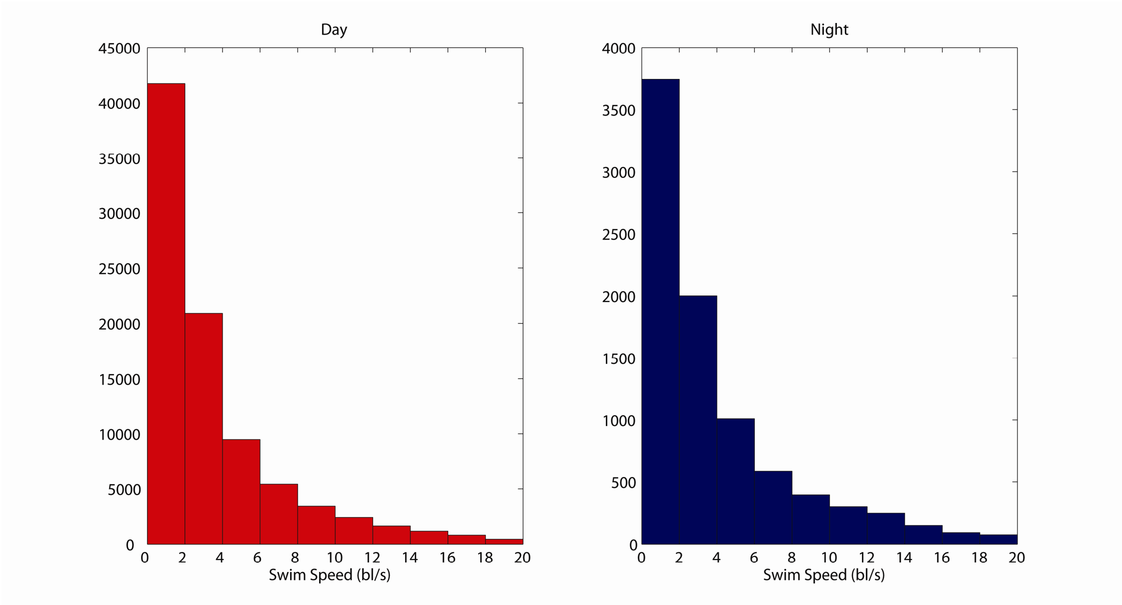

Figure G.80. The daytime and nighttime swimming speeds (body lengths/second) of Fish 33700 are plotted over the course of the study period (August 8 – 23, 2005).

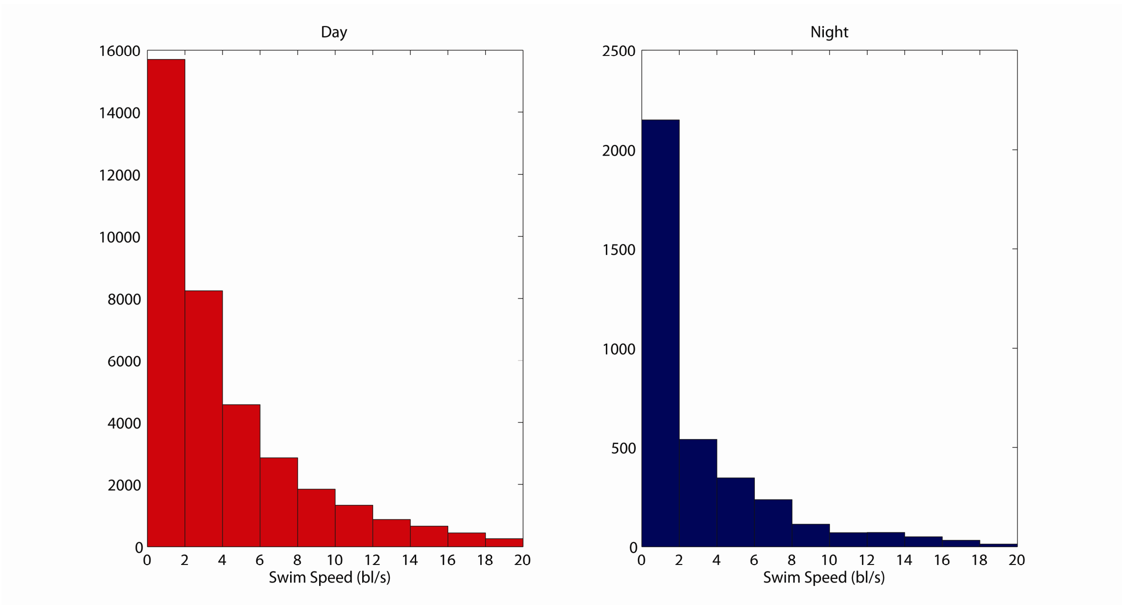

Figure G.81. The daytime and nighttime swimming speeds (body lengths/second) of Fish 34200 are plotted over the course of the study period (August 8 – 27, 2005).

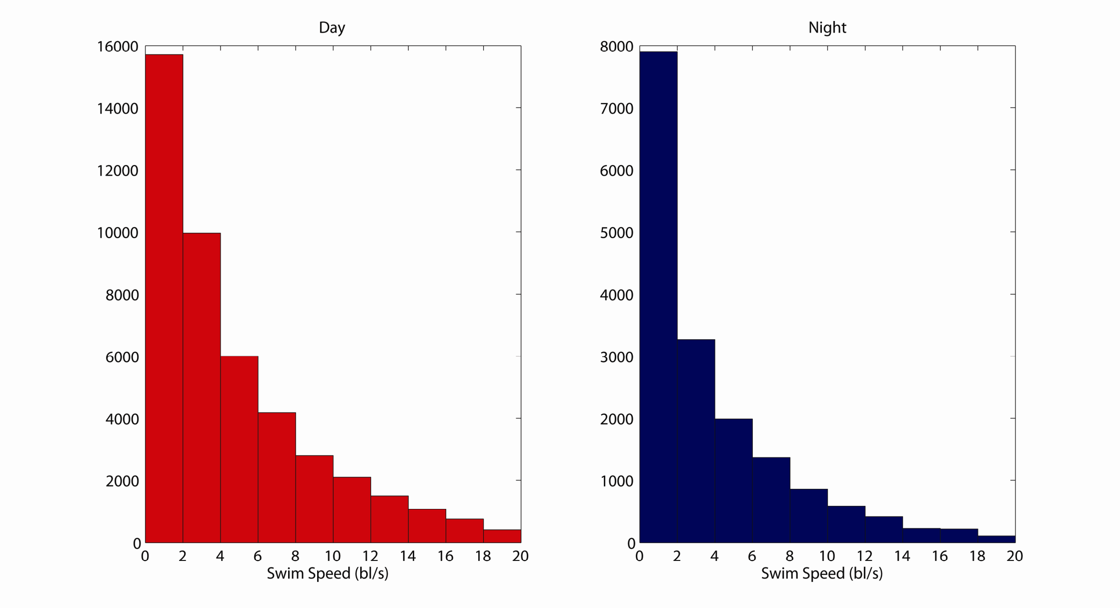

Figure G.82. The daytime and nighttime swimming speeds (body lengths/second) of Fish 34300 are plotted over the course of the study period (August 8 – 27, 2005).

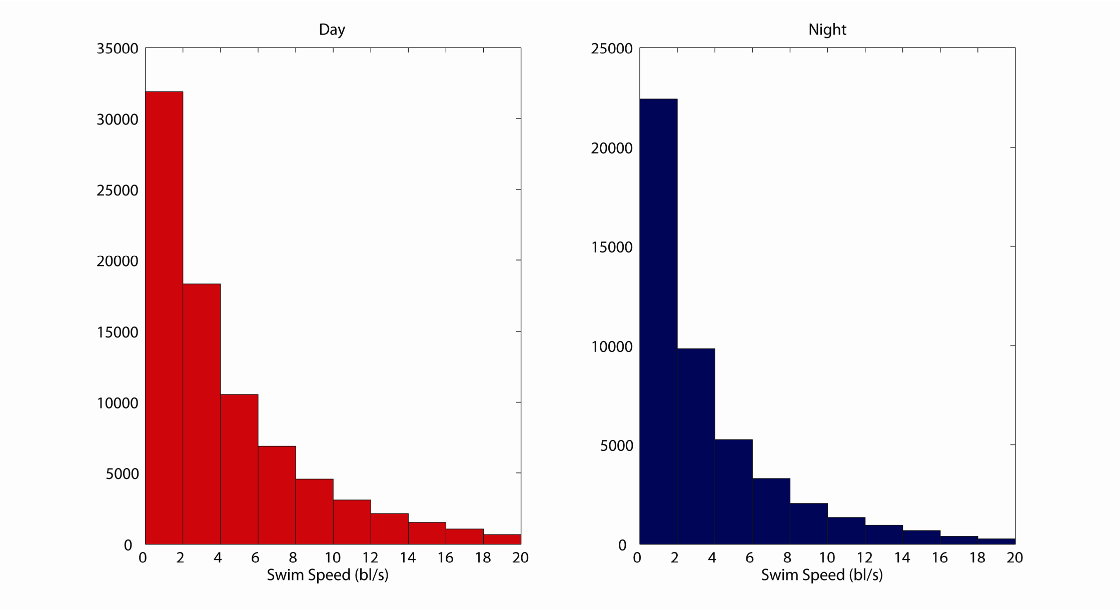

Figure G.83. The daytime and nighttime swimming speeds (body lengths/second) of Fish 34600 are plotted over the course of the study period (August 9 – 26, 2005).

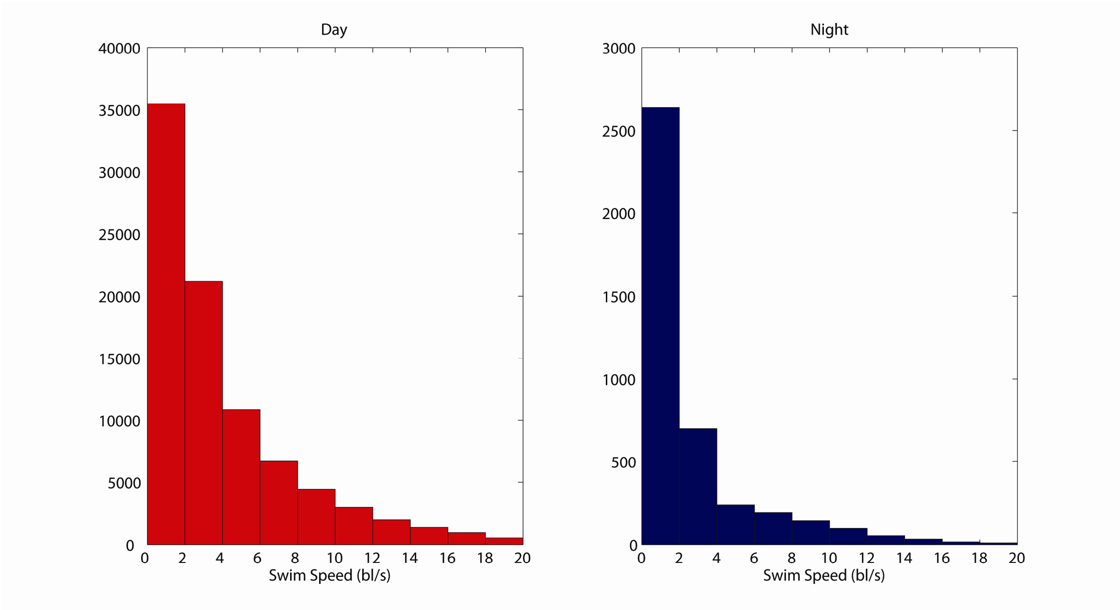

Figure G.84. The daytime and nighttime swimming speeds (body lengths/second) of Fish 34800 are plotted over the course of the study period (August 8 – 27, 2005).

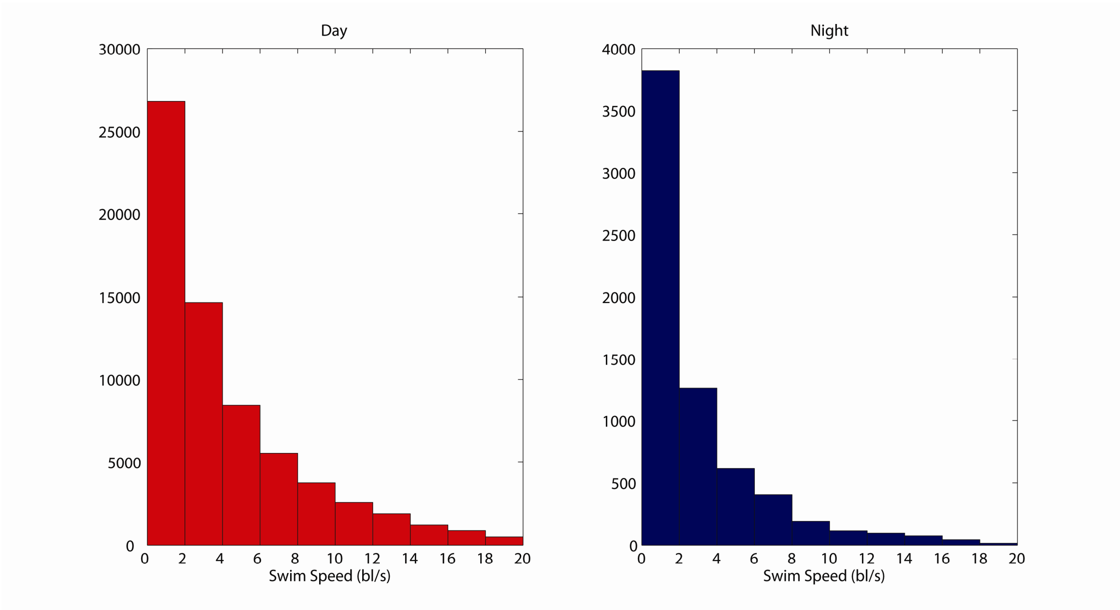

Figure G.85. The daytime and nighttime swimming speeds (body lengths/second) of Fish 34900 are plotted over the course of the study period (August 8 – 27, 2005).

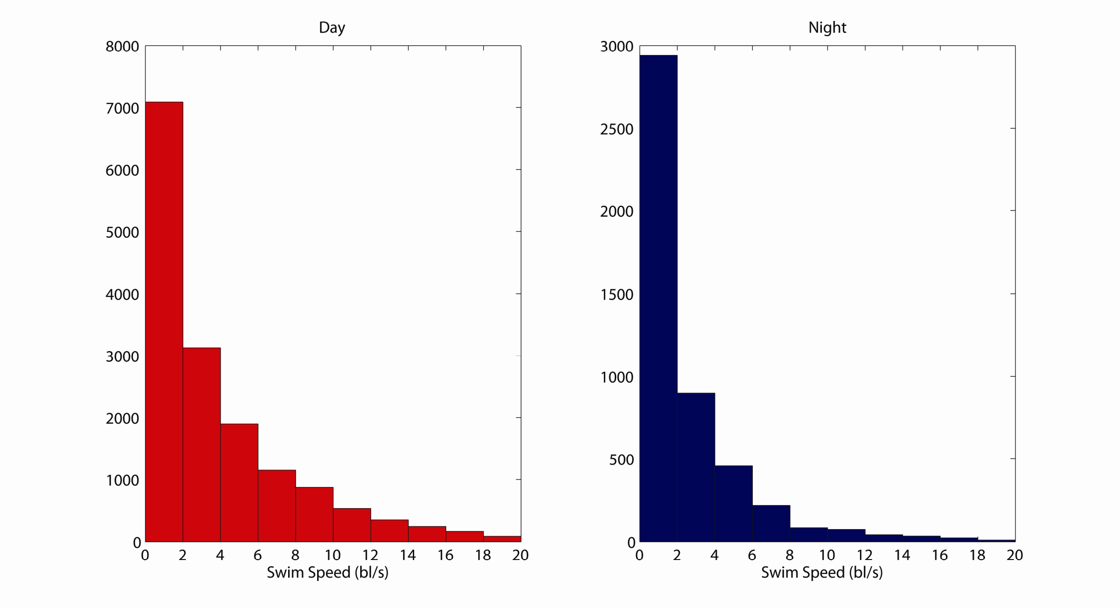

Figure G.86. The daytime and nighttime swimming speeds (body lengths/second) of Fish 35000 are plotted over the course of the study period (August 9 – 16, 2005).

APPENDIX H

MATLAB CODE

allschool36.m

```
temp=dist29500(:,2:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist29500(:,1) temp];
school29500=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:32)<=36);
      if isempty(k);
         a=a+1;
      else
         school29500=[school29500;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist30100(:,3:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist30100(:,1) temp];
school30100=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:31)<=36);
      if isempty(k);
         a=a+1;
      else
         school30100=[school30100;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist30200(:,4:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
```

```
temp=[dist30200(:,1) temp];
school30200=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:30)<=36);
      if isempty(k);
         a=a+1;
      else
         school30200=[school30200;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist30500(:,5:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist30500(:,1) temp];
school30500=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:29)<=36);
      if isempty(k);
         a=a+1;
      else
         school30500=[school30500;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist30600(:,6:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist30600(:,1) temp];
school30600=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:28)<=36);
      if isempty(k);
         a=a+1;
      else
         school30600=[school30600;temp(a,:)];
         a=a+1;
      end
   end
```

```
clear a k temp

temp=dist30800(:,7:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist30800(:,1) temp];
school30800=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:27)<=36);
      if isempty(k);
         a=a+1;
      else
         school30800=[school30800;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist31200(:,8:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist31200(:,1) temp];
school31200=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:26)<=36);
      if isempty(k);
         a=a+1;
      else
         school31200=[school31200;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist31300(:,9:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist31300(:,1) temp];
school31300=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:25)<=36);
```

```
        if isempty(k);
            a=a+1;
        else
            school31300=[school31300;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist31400(:,10:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist31400(:,1) temp];
school31400=[];
a=1;
    while a<=17280;
        k=find(temp(a,2:24)<=36);
        if isempty(k);
            a=a+1;
        else
            school31400=[school31400;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist31500(:,11:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist31500(:,1) temp];
school31500=[];
a=1;
    while a<=17280;
        k=find(temp(a,2:23)<=36);
        if isempty(k);
            a=a+1;
        else
            school31500=[school31500;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist31600(:,12:32);
k=find(temp>36);
temp(k)=NaN;
```

```
k=find(temp==0);
temp(k)=NaN;
temp=[dist31600(:,1) temp];
school31600=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:22)<=36);
      if isempty(k);
         a=a+1;
      else
         school31600=[school31600;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist31800(:,13:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist31800(:,1) temp];
school31800=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:21)<=36);
      if isempty(k);
         a=a+1;
      else
         school31800=[school31800;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist32100(:,14:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist32100(:,1) temp];
school32100=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:20)<=36);
      if isempty(k);
         a=a+1;
      else
         school32100=[school32100;temp(a,:)];
         a=a+1;
```

```
        end
    end
clear a k temp

temp=dist32300(:,15:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist32300(:,1) temp];
school32300=[];
a=1;
    while a<=17280;
        k=find(temp(a,2:19)<=36);
        if isempty(k);
            a=a+1;
        else
            school32300=[school32300;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist32400(:,16:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist32400(:,1) temp];
school32400=[];
a=1;
    while a<=17280;
        k=find(temp(a,2:18)<=36);
        if isempty(k);
            a=a+1;
        else
            school32400=[school32400;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist32500(:,17:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist32500(:,1) temp];
school32500=[];
a=1;
```

```
    while a<=17280;
        k=find(temp(a,2:17)<=36);
        if isempty(k);
            a=a+1;
        else
            school32500=[school32500;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist32700(:,18:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist32700(:,1) temp];
school32700=[];
a=1;
    while a<=17280;
        k=find(temp(a,2:16)<=36);
        if isempty(k);
            a=a+1;
        else
            school32700=[school32700;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist32900(:,19:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist32900(:,1) temp];
school32900=[];
a=1;
    while a<=17280;
        k=find(temp(a,2:15)<=36);
        if isempty(k);
            a=a+1;
        else
            school32900=[school32900;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist33000(:,20:32);
```

```
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist33000(:,1) temp];
school33000=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:14)<=36);
      if isempty(k);
         a=a+1;
      else
         school33000=[school33000;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist33200(:,21:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist33200(:,1) temp];
school33200=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:13)<=36);
      if isempty(k);
         a=a+1;
      else
         school33200=[school33200;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist33300(:,22:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist33300(:,1) temp];
school33300=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:12)<=36);
      if isempty(k);
         a=a+1;
      else
```

```
            school33300=[school33300;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist33500(:,23:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist33500(:,1) temp];
school33500=[];
a=1;
    while a<=17280;
        k=find(temp(a,2:11)<=36);
        if isempty(k);
            a=a+1;
        else
            school33500=[school33500;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist33600(:,24:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist33600(:,1) temp];
school33600=[];
a=1;
    while a<=17280;
        k=find(temp(a,2:10)<=36);
        if isempty(k);
            a=a+1;
        else
            school33600=[school33600;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist33700(:,25:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist33700(:,1) temp];
```

```
school33700=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:9)<=36);
      if isempty(k);
         a=a+1;
      else
         school33700=[school33700;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist33800(:,26:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist33800(:,1) temp];
school33800=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:8)<=36);
      if isempty(k);
         a=a+1;
      else
         school33800=[school33800;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist34000(:,27:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist34000(:,1) temp];
school34000=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:7)<=36);
      if isempty(k);
         a=a+1;
      else
         school34000=[school34000;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp
```

```
temp=dist34200(:,28:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist34200(:,1) temp];
school34200=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:6)<=36);
      if isempty(k);
         a=a+1;
      else
         school34200=[school34200;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist34300(:,29:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist34300(:,1) temp];
school34300=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:5)<=36);
      if isempty(k);
         a=a+1;
      else
         school34300=[school34300;temp(a,:)];
         a=a+1;
      end
   end
clear a k temp

temp=dist34600(:,30:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist34600(:,1) temp];
school34600=[];
a=1;
   while a<=17280;
      k=find(temp(a,2:4)<=36);
      if isempty(k);
```

```
            a=a+1;
        else
            school34600=[school34600;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist34800(:,31:32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist34800(:,1) temp];
school34800=[];
a=1;
    while a<=17280;
        k=find(temp(a,2:3)<=36);
        if isempty(k);
            a=a+1;
        else
            school34800=[school34800;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp

temp=dist34900(:,32);
k=find(temp>36);
temp(k)=NaN;
k=find(temp==0);
temp(k)=NaN;
temp=[dist34900(:,1) temp];
school34900=[];
a=1;
    while a<=17280;
        k=find(temp(a,2)<=36);
        if isempty(k);
            a=a+1;
        else
            school34900=[school34900;temp(a,:)];
            a=a+1;
        end
    end
clear a k temp
```

bindata5min.m

```
files=who;
temp2=[]; dist=[];

for a=1:length(files)
   eval(['daily=' char(files(a)) ';'])
   if length(daily)>0
      %k=find(daily(1:end-1,2)-daily(2:end,2)==0);
      %daily(k,:)=[];
      %daily(:,2)=(daily(:,2)-1104451200)/86400;
      d=floor(daily(:,2)); d=d(1);
      daily(:,2)=(daily(:,2)-d)*86400;
      k=find(daily(:,3)>35);
      daily(k,:)=[];
      b=300;
      for c=1:290
         k=find(daily(:,2)<b);
         if length(k)>0
            temp2=[temp2;mean(daily(k,2)) mean(daily(k,3))];
            daily(k,:)=[];
         end
         b=b+300;
      end
   end
   if length(temp2)>0
   temp2(:,1)=(temp2(:,1)/86400)+d;
   dist=[dist;temp2];
   end
   temp2=[];
   clear daily
end

clear a b k c d m n temp2 files
```

br_data_process.m

```
%Biomap .txt data filtering into Matlab

%1. Delete duplications

k=find((data(2:end,2)-data(1:end-1,2))==0);
data(k,:)=[];
clear k;
%repeat to check for other duplications.

%2. time
time=(data(:,2)-1104451200)/86400; %corrected for YD
data=[data(:,1) time data(:,3)];
```

chisquaredata.m

```
%This routine separates the data into two depth strata by time of day - the
%first depth srata is less than or equal to 10m (surface) and the second
%depth strata is greater than 10m (depth).  It also accumulates the number
%of data lines in each variable and creates the x2data variable for use in
%a contingency table analysis.


k=find(dawn(:,3)<=10);
dawn_surf=dawn(k,:);
k=find(dawn(:,3)>10);
dawn_depth=dawn(k,:);

k=find(day(:,3)<=10);
day_surf=day(k,:);
k=find(day(:,3)>10);
day_depth=day(k,:);

k=find(dusk(:,3)<=10);
dusk_surf=dusk(k,:);
k=find(dusk(:,3)>10);
dusk_depth=dusk(k,:);

k=find(night(:,3)<=10);
night_surf=night(k,:);
k=find(night(:,3)>10);
night_depth=night(k,:);

a=length(dawn_surf);
b=length(dawn_depth);
c=length(day_surf);
d=length(day_depth);
e=length(dusk_surf);
f=length(dusk_depth);
g=length(night_surf);
h=length(night_depth);

x2data=[a c e g;b d f h];

clear a b c d e f g h k
```

ctddata.m

```
files=who;
for a=1:length(files)
    eval(['data=' char(files(end)) ';'])
end
data(:,13)=[];
data(:,11)=[];
data(:,8:9)=[];
data(:,1:3)=[];
ss=data(:,3)/60;
mm=(data(:,2)+ss)/60;
hh=(data(:,1)+mm)/24;
date=day+hh;
data(:,1:3)=[];
data=[date data];
b=max(data(:,4));
k=find(data(:,4)==b);
data(1:k,:)=[];
k=find(data(:,4)<=0);
data(k,:)=[];
k=find(data(:,3)<10);
data(k,:)=[];

eval(['ctd' num2str(day) '_' num2str(a) '=data;'])

clear d* hh mm ss x* k a b files
```

day05.m

```
%day05.m finds all the data found between sunrise and sunset during the
%2005 research
%Put data into a temp file called data which has four columns - TagId,
%yearday, depth and power

k=find(data(:,2)<216.784028); %finds data before sunset on 4Aug05
temp=data(k,:); %assigns all data to a temp variable
day=temp; %assigns daytime data to new variable

k=find(data(:,2)>217.225694); %finds data after sunrise on 5Aug05
temp=data(k,:); %assigns all data to a temp variable
k=find(temp(:,2)<217.784028); %finds data before sunset on 5Aug05
temp=temp(k,:); %filters out only the dayime data
day=[day;temp]; %appends the second day's data to the first day's

k=find(data(:,2)>218.225694); %finds data after sunrise on 6Aug05
temp=data(k,:);
k=find(temp(:,2)<218.783333); %finds data before sunset on 6Aug05
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>219.226389);
temp=data(k,:);
k=find(temp(:,2)<219.782369);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>220.227083);
temp=data(k,:);
k=find(temp(:,2)<220.781944);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>221.227083);
temp=data(k,:);
k=find(temp(:,2)<221.781250);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>222.227778);
temp=data(k,:);
k=find(temp(:,2)<222.781250);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>223.227778);
temp=data(k,:);
k=find(temp(:,2)<223.780556);
```

```
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>224.228472);
temp=data(k,:);
k=find(temp(:,2)<224.779861);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>225.228472);
temp=data(k,:);
k=find(temp(:,2)<225.779167);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>226.229167);
temp=data(k,:);
k=find(temp(:,2)<226.778472);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>227.229167);
temp=data(k,:);
k=find(temp(:,2)<227.777778);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>228.229861);
temp=data(k,:);
k=find(temp(:,2)<228.777083);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>229.229861);
temp=data(k,:);
k=find(temp(:,2)<229.776389);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>230.230556);
temp=data(k,:);
k=find(temp(:,2)<230.775694);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>231.231250);
temp=data(k,:);
k=find(temp(:,2)<231.775000);
temp=temp(k,:);
day=[day;temp];
```

```
k=find(data(:,2)>232.231250);
temp=data(k,:);
k=find(temp(:,2)<232.774306);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>233.231944);
temp=data(k,:);
k=find(temp(:,2)<233.773611);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>234.231944);
temp=data(k,:);
k=find(temp(:,2)<234.772917);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>235.232639);
temp=data(k,:);
k=find(temp(:,2)<235.772222);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>236.232639);
temp=data(k,:);
k=find(temp(:,2)<236.771528);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>237.233333);
temp=data(k,:);
k=find(temp(:,2)<237.770833);
temp=temp(k,:);
day=[day;temp];

k=find(data(:,2)>238.233333);
temp=data(k,:);
k=find(temp(:,2)<238.770139);
temp=temp(k,:);
day=[day;temp];

clear k temp data
```

daynightshooling.m

```
clear b* d* k n* s*

files=who;
day=218;

for a=1:length(files)
   data=[];
   eval(['datafile=' char(files(a)) ';']);
   %datafile(:,1)=(datafile(:,1)/86400)+day;
   day=day+1;
   k=isnan(datafile);
   datafile(k)=9999;
   for b=1:17280
      k=find(datafile(b,2:end)<=36);
      if length(k)>0
         data=[data;datafile(b,:)];
      end
   end
   eval([char(files(a)) '=data;'])
end

clear day datafile k a b files data

files=who;
data=[];
for a=1:length(files)
   eval(['datafile=' char(files(a)) ';']);
   data=[data;datafile];
end

clear files a b k day
day=[];
night=[];

k=find(data(:,1)<219);
day218=data(k,:);
data(k,:)=[];
k=find(day218(:,1)<218.2049);
night=[night;day218(k,:)];
day218(k,:)=[];
k=find(day218(:,1)<218.2465);
day218(k,:)=[];
k=find(day218(:,1)<218.7625);
day=[day;day218(k,:)];
day218(k,:)=[];
k=find(day218(:,1)<218.8042);
day218(k,:)=[];
night=[night;day218];
```

```
clear day218

k=find(data(:,1)<220);
day219=data(k,:);
data(k,:)=[];
k=find(day219(:,1)<219.2056);
night=[night;day219(k,:)];
day219(k,:)=[];
k=find(day219(:,1)<219.2472);
day219(k,:)=[];
k=find(day219(:,1)<219.7618);
day=[day;day219(k,:)];
day219(k,:)=[];
k=find(day219(:,1)<219.8035);
day219(k,:)=[];
night=[night;day219];
clear day219

k=find(data(:,1)<221);
day220=data(k,:);
data(k,:)=[];
k=find(day220(:,1)<220.2062);
night=[night;day220(k,:)];
day220(k,:)=[];
k=find(day220(:,1)<220.2479);
day220(k,:)=[];
k=find(day220(:,1)<220.7611);
day=[day;day220(k,:)];
day220(k,:)=[];
k=find(day220(:,1)<220.8028);
day220(k,:)=[];
night=[night;day220];
clear day220

k=find(data(:,1)<222);
day221=data(k,:);
data(k,:)=[];
k=find(day221(:,1)<221.2062);
night=[night;day221(k,:)];
day221(k,:)=[];
k=find(day221(:,1)<221.2479);
day221(k,:)=[];
k=find(day221(:,1)<221.7604);
day=[day;day221(k,:)];
day221(k,:)=[];
k=find(day221(:,1)<221.8021);
day221(k,:)=[];
night=[night;day221];
clear day221
```

```
k=find(data(:,1)<223);
day222=data(k,:);
data(k,:)=[];
k=find(day222(:,1)<222.2069);
night=[night;day222(k,:)];
day222(k,:)=[];
k=find(day222(:,1)<222.2486);
day222(k,:)=[];
k=find(day222(:,1)<222.7604);
day=[day;day222(k,:)];
day222(k,:)=[];
k=find(day222(:,1)<222.8021);
day222(k,:)=[];
night=[night;day222];
clear day222

k=find(data(:,1)<224);
day223=data(k,:);
data(k,:)=[];
k=find(day223(:,1)<223.2069);
night=[night;day223(k,:)];
day223(k,:)=[];
k=find(day223(:,1)<223.2486);
day223(k,:)=[];
k=find(day223(:,1)<223.7597);
day=[day;day223(k,:)];
day223(k,:)=[];
k=find(day223(:,1)<223.8014);
day223(k,:)=[];
night=[night;day223];
clear day223

k=find(data(:,1)<225);
day224=data(k,:);
data(k,:)=[];
k=find(day224(:,1)<224.2076);
night=[night;day224(k,:)];
day224(k,:)=[];
k=find(day224(:,1)<224.2493);
day224(k,:)=[];
k=find(day224(:,1)<224.7590);
day=[day;day224(k,:)];
day224(k,:)=[];
k=find(day224(:,1)<224.8007);
day224(k,:)=[];
night=[night;day224];
clear day224

k=find(data(:,1)<226);
day225=data(k,:);
```

```
data(k,:)=[];
k=find(day225(:,1)<225.2076);
night=[night;day225(k,:)];
day225(k,:)=[];
k=find(day225(:,1)<225.2493);
day225(k,:)=[];
k=find(day225(:,1)<225.7583);
day=[day;day225(k,:)];
day225(k,:)=[];
k=find(day225(:,1)<225.8000);
day225(k,:)=[];
night=[night;day225];
clear day225

k=find(data(:,1)<227);
day226=data(k,:);
data(k,:)=[];
k=find(day226(:,1)<226.2083);
night=[night;day226(k,:)];
day226(k,:)=[];
k=find(day226(:,1)<226.2500);
day226(k,:)=[];
k=find(day226(:,1)<226.7576);
day=[day;day226(k,:)];
day226(k,:)=[];
k=find(day226(:,1)<226.7993);
day226(k,:)=[];
night=[night;day226];
clear day226

k=find(data(:,1)<228);
day227=data(k,:);
data(k,:)=[];
k=find(day227(:,1)<227.2083);
night=[night;day227(k,:)];
day227(k,:)=[];
k=find(day227(:,1)<227.2500);
day227(k,:)=[];
k=find(day227(:,1)<227.7569);
day=[day;day227(k,:)];
day227(k,:)=[];
k=find(day227(:,1)<227.7986);
day227(k,:)=[];
night=[night;day227];
clear day227

k=find(data(:,1)<229);
day228=data(k,:);
data(k,:)=[];
k=find(day228(:,1)<228.2090);
```

```
night=[night;day228(k,:)];
day228(k,:)=[];
k=find(day228(:,1)<228.2507);
day228(k,:)=[];
k=find(day228(:,1)<228.7562);
day=[day;day228(k,:)];
day228(k,:)=[];
k=find(day228(:,1)<228.7979);
day228(k,:)=[];
night=[night;day228];
clear day228

k=find(data(:,1)<230);
day229=data(k,:);
data(k,:)=[];
k=find(day229(:,1)<229.2090);
night=[night;day229(k,:)];
day229(k,:)=[];
k=find(day229(:,1)<229.2507);
day229(k,:)=[];
k=find(day229(:,1)<229.7556);
day=[day;day229(k,:)];
day229(k,:)=[];
k=find(day229(:,1)<229.7972);
day229(k,:)=[];
night=[night;day229];
clear day229

k=find(data(:,1)<231);
day230=data(k,:);
data(k,:)=[];
k=find(day230(:,1)<230.2097);
night=[night;day230(k,:)];
day230(k,:)=[];
k=find(day230(:,1)<230.2514);
day230(k,:)=[];
k=find(day230(:,1)<230.7549);
day=[day;day230(k,:)];
day230(k,:)=[];
k=find(day230(:,1)<230.7965);
day230(k,:)=[];
night=[night;day230];
clear day230

k=find(data(:,1)<232);
day231=data(k,:);
data(k,:)=[];
k=find(day231(:,1)<231.2104);
night=[night;day231(k,:)];
day231(k,:)=[];
```

```
k=find(day231(:,1)<231.2521);
day231(k,:)=[];
k=find(day231(:,1)<231.7542);
day=[day;day231(k,:)];
day231(k,:)=[];
k=find(day231(:,1)<231.7958);
day231(k,:)=[];
night=[night;day231];
clear day231

k=find(data(:,1)<233);
day232=data(k,:);
data(k,:)=[];
k=find(day232(:,1)<232.2104);
night=[night;day232(k,:)];
day232(k,:)=[];
k=find(day232(:,1)<232.2521);
day232(k,:)=[];
k=find(day232(:,1)<232.7535);
day=[day;day232(k,:)];
day232(k,:)=[];
k=find(day232(:,1)<232.7951);
day232(k,:)=[];
night=[night;day232];
clear day232

k=find(data(:,1)<234);
day233=data(k,:);
data(k,:)=[];
k=find(day233(:,1)<233.2111);
night=[night;day233(k,:)];
day233(k,:)=[];
k=find(day233(:,1)<233.2528);
day233(k,:)=[];
k=find(day233(:,1)<233.7528);
day=[day;day233(k,:)];
day233(k,:)=[];
k=find(day233(:,1)<233.7944);
day233(k,:)=[];
night=[night;day233];
clear day233

k=find(data(:,1)<235);
day234=data(k,:);
data(k,:)=[];
k=find(day234(:,1)<234.2111);
night=[night;day234(k,:)];
day234(k,:)=[];
k=find(day234(:,1)<234.2528);
day234(k,:)=[];
```

```
k=find(day234(:,1)<234.7521);
day=[day;day234(k,:)];
day234(k,:)=[];
k=find(day234(:,1)<234.7938);
day234(k,:)=[];
night=[night;day234];
clear day234

k=find(data(:,1)<236);
day235=data(k,:);
data(k,:)=[];
k=find(day235(:,1)<235.2118);
night=[night;day235(k,:)];
day235(k,:)=[];
k=find(day235(:,1)<235.2535);
day235(k,:)=[];
k=find(day235(:,1)<235.7514);
day=[day;day235(k,:)];
day235(k,:)=[];
k=find(day235(:,1)<235.7931);
day235(k,:)=[];
night=[night;day235];
clear day235

k=find(data(:,1)<237);
day236=data(k,:);
data(k,:)=[];
k=find(day236(:,1)<236.2118);
night=[night;day236(k,:)];
day236(k,:)=[];
k=find(day236(:,1)<236.2535);
day236(k,:)=[];
k=find(day236(:,1)<236.7507);
day=[day;day236(k,:)];
day236(k,:)=[];
k=find(day236(:,1)<236.7924);
day236(k,:)=[];
night=[night;day236];
clear day236

k=find(data(:,1)<238);
day237=data(k,:);
data(k,:)=[];
k=find(day237(:,1)<237.2125);
night=[night;day237(k,:)];
day237(k,:)=[];
k=find(day237(:,1)<237.2542);
day237(k,:)=[];
k=find(day237(:,1)<237.7500);
day=[day;day237(k,:)];
```

```
day237(k,:)=[];
k=find(day237(:,1)<237.7917);
day237(k,:)=[];
night=[night;day237];
clear day237

k=find(data(:,1)<239);
day238=data(k,:);
data(k,:)=[];
k=find(day238(:,1)<238.2125);
night=[night;day238(k,:)];
day238(k,:)=[];
k=find(day238(:,1)<238.2542);
day238(k,:)=[];
k=find(day238(:,1)<238.7493);
day=[day;day238(k,:)];
day238(k,:)=[];
k=find(day238(:,1)<238.7910);
day238(k,:)=[];
night=[night;day238];
clear day238

day239=data;
k=find(day239(:,1)<239.2125);
night=[night;day239(k,:)];
day239(k,:)=[];
k=find(day239(:,1)<239.2542);
day239(k,:)=[];
day=[day;day239];
clear day239 k data

julian=219;
date=06;

for a=1:22
   k=find(day(:,1)<julian);
   if length(k)>0
      eval(['aug' num2str(date) 'd=day(k,:);'])
      day(k,:)=[];
      julian=julian+1;  date=date+1;
   else
      julian=julian+1;  date=date+1;
   end
end

julian=219;
date=06;

for a=1:22
   k=find(night(:,1)<julian);
```

```
    if length(k)>0
        eval(['aug' num2str(date) 'n=night(k,:);'])
        night(k,:)=[];
        julian=julian+1;  date=date+1;
        else
        julian=julian+1;  date=date+1;
    end
end

clear day night a k julian date datafile
```

days.m

```
stats=[];
a=227;

k=find(data(:,1)<228);
aug15=data(k,:);
data(k,:)=[];
if length(aug15)>0
   aug15mean=mean(aug15(:,3));
   aug15std=std(aug15(:,3));
   temp=[a aug15mean aug15std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<229);
aug16=data(k,:);
data(k,:)=[];
if length(aug16)>0
   aug16mean=mean(aug16(:,3));
   aug16std=std(aug16(:,3));
   temp=[a aug16mean aug16std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<230);
aug17=data(k,:);
data(k,:)=[];
if length(aug17)>0
   aug17mean=mean(aug17(:,3));
   aug17std=std(aug17(:,3));
   temp=[a aug17mean aug17std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<231);
aug18=data(k,:);
data(k,:)=[];
if length(aug18)>0
   aug18mean=mean(aug18(:,3));
   aug18std=std(aug18(:,3));
   temp=[a aug18mean aug18std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<232);
```

```
aug19=data(k,:);
data(k,:)=[];
if length(aug19)>0
   aug19mean=mean(aug19(:,3));
   aug19std=std(aug19(:,3));
   temp=[a aug19mean aug19std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<233);
aug20=data(k,:);
data(k,:)=[];
if length(aug20)>0
   aug20mean=mean(aug20(:,3));
   aug20std=std(aug20(:,3));
   temp=[a aug20mean aug20std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<234);
aug21=data(k,:);
data(k,:)=[];
if length(aug21)>0
   aug21mean=mean(aug21(:,3));
   aug21std=std(aug21(:,3));
   temp=[a aug21mean aug21std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<235);
aug22=data(k,:);
data(k,:)=[];
if length(aug22)>0
   aug22mean=mean(aug22(:,3));
   aug22std=std(aug22(:,3));
   temp=[a aug22mean aug22std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<236);
aug23=data(k,:);
data(k,:)=[];
if length(aug23)>0
   aug23mean=mean(aug23(:,3));
   aug23std=std(aug23(:,3));
   temp=[a aug23mean aug23std];
```

```
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<237);
aug24=data(k,:);
data(k,:)=[];
if length(aug24)>0
    aug24mean=mean(aug24(:,3));
    aug24std=std(aug24(:,3));
    temp=[a aug24mean aug24std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<238);
aug25=data(k,:);
data(k,:)=[];
if length(aug25)>0
    aug25mean=mean(aug25(:,3));
    aug25std=std(aug25(:,3));
    temp=[a aug25mean aug25std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<239);
aug26=data(k,:);
data(k,:)=[];
if length(aug26)>0
    aug26mean=mean(aug26(:,3));
    aug26std=std(aug26(:,3));
    temp=[a aug26mean aug26std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<240);
aug27=data(k,:);
data(k,:)=[];
if length(aug27)>0
    aug27mean=mean(aug27(:,3));
    aug27std=std(aug27(:,3));
    temp=[a aug27mean aug27std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<241);
aug28=data(k,:);
```

```
data(k,:)=[];
if length(aug28)>0
   aug28mean=mean(aug28(:,3));
   aug28std=std(aug28(:,3));
   temp=[a aug28mean aug28std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<242);
aug29=data(k,:);
data(k,:)=[];
if length(aug29)>0
   aug29mean=mean(aug29(:,3));
   aug29std=std(aug29(:,3));
   temp=[a aug29mean aug29std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<243);
aug30=data(k,:);
data(k,:)=[];
if length(aug30)>0
   aug30mean=mean(aug30(:,3));
   aug30std=std(aug30(:,3));
   temp=[a aug30mean aug30std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<244);
aug31=data(k,:);
data(k,:)=[];
if length(aug31)>0
   aug31mean=mean(aug31(:,3));
   aug31std=std(aug31(:,3));
   temp=[a aug31mean aug31std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<245);
sep1=data(k,:);
data(k,:)=[];
if length(sep1)>0
   sep1mean=mean(sep1(:,3));
   sep1std=std(sep1(:,3));
   temp=[a sep1mean sep1std];
   stats=[stats;temp];
```

```
end
a=a+1;

k=find(data(:,1)<246);
sep2=data(k,:);
data(k,:)=[];
if length(sep2)>0
   sep2mean=mean(sep2(:,3));
   sep2std=std(sep2(:,3));
   temp=[a sep2mean sep2std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<247);
sep3=data(k,:);
data(k,:)=[];
if length(sep3)>0
   sep3mean=mean(sep3(:,3));
   sep3std=std(sep3(:,3));
   temp=[a sep3mean sep3std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<248);
sep4=data(k,:);
data(k,:)=[];
if length(sep4)>0
   sep4mean=mean(sep4(:,3));
   sep4std=std(sep4(:,3));
   temp=[a sep4mean sep4std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<249);
sep5=data(k,:);
data(k,:)=[];
if length(sep5)>0
   sep5mean=mean(sep5(:,3));
   sep5std=std(sep5(:,3));
   temp=[a sep5mean sep5std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<250);
sep6=data(k,:);
data(k,:)=[];
```

```
if length(sep6)>0
   sep6mean=mean(sep6(:,3));
   sep6std=std(sep6(:,3));
   temp=[a sep6mean sep6std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<251);
sep7=data(k,:);
data(k,:)=[];
if length(sep7)>0
   sep7mean=mean(sep7(:,3));
   sep7std=std(sep7(:,3));
   temp=[a sep7mean sep7std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<252);
sep8=data(k,:);
data(k,:)=[];
if length(sep8)>0
   sep8mean=mean(sep8(:,3));
   sep8std=std(sep8(:,3));
   temp=[a sep8mean sep8std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<253);
sep9=data(k,:);
data(k,:)=[];
if length(sep9)>0
   sep9mean=mean(sep9(:,3));
   sep9std=std(sep9(:,3));
   temp=[a sep9mean sep9std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<254);
sep10=data(k,:);
data(k,:)=[];
if length(sep10)>0
   sep10mean=mean(sep10(:,3));
   sep10std=std(sep10(:,3));
   temp=[a sep10mean sep10std];
   stats=[stats;temp];
end
```

```
a=a+1;

k=find(data(:,1)<255);
sep11=data(k,:);
data(k,:)=[];
if length(sep11)>0
   sep11mean=mean(sep11(:,3));
   sep11std=std(sep11(:,3));
   temp=[a sep11mean sep11std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<256);
sep12=data(k,:);
data(k,:)=[];
if length(sep12)>0
   sep12mean=mean(sep12(:,3));
   sep12std=std(sep12(:,3));
   temp=[a sep12mean sep12std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<257);
sep13=data(k,:);
data(k,:)=[];
if length(sep13)>0
   sep13mean=mean(sep13(:,3));
   sep13std=std(sep13(:,3));
   temp=[a sep13mean sep13std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<258);
sep14=data(k,:);
data(k,:)=[];
if length(sep14)>0
   sep14mean=mean(sep14(:,3));
   sep14std=std(sep14(:,3));
   temp=[a sep14mean sep14std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<259);
sep15=data(k,:);
data(k,:)=[];
if length(sep15)>0
```

```
    sep15mean=mean(sep15(:,3));
    sep15std=std(sep15(:,3));
    temp=[a sep15mean sep15std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<260);
sep16=data(k,:);
data(k,:)=[];
if length(sep16)>0
    sep16mean=mean(sep16(:,3));
    sep16std=std(sep16(:,3));
    temp=[a sep16mean sep16std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<261);
sep17=data(k,:);
data(k,:)=[];
if length(sep17)>0
    sep17mean=mean(sep17(:,3));
    sep17std=std(sep17(:,3));
    temp=[a sep17mean sep17std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<262);
sep18=data(k,:);
data(k,:)=[];
if length(sep18)>0
    sep18mean=mean(sep18(:,3));
    sep18std=std(sep18(:,3));
    temp=[a sep18mean sep18std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<263);
sep19=data(k,:);
data(k,:)=[];
if length(sep19)>0
    sep19mean=mean(sep19(:,3));
    sep19std=std(sep19(:,3));
    temp=[a sep19mean sep19std];
    stats=[stats;temp];
end
a=a+1;
```

```
k=find(data(:,1)<264);
sep20=data(k,:);
data(k,:)=[];
if length(sep10)>0
   sep20mean=mean(sep20(:,3));
   sep20std=std(sep20(:,3));
   temp=[a sep20mean sep20std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<265);
sep21=data(k,:);
data(k,:)=[];
if length(sep21)>0
   sep21mean=mean(sep21(:,3));
   sep21std=std(sep21(:,3));
   temp=[a sep21mean sep21std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<266);
sep22=data(k,:);
data(k,:)=[];
if length(sep22)>0
   sep22mean=mean(sep22(:,3));
   sep22std=std(sep22(:,3));
   temp=[a sep22mean sep22std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<267);
sep23=data(k,:);
data(k,:)=[];
if length(sep23)>0
   sep23mean=mean(sep23(:,3));
   sep23std=std(sep23(:,3));
   temp=[a sep23mean sep23std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<268);
sep24=data(k,:);
data(k,:)=[];
if length(sep24)>0
   sep24mean=mean(sep24(:,3));
```

```
    sep24std=std(sep24(:,3));
    temp=[a sep24mean sep24std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<269);
sep25=data(k,:);
data(k,:)=[];
if length(sep25)>0
    sep25mean=mean(sep25(:,3));
    sep25std=std(sep25(:,3));
    temp=[a sep25mean sep25std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<270);
sep26=data(k,:);
data(k,:)=[];
if length(sep26)>0
    sep26mean=mean(sep26(:,3));
    sep26std=std(sep26(:,3));
    temp=[a sep26mean sep26std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<271);
sep27=data(k,:);
data(k,:)=[];
if length(sep27)>0
    sep27mean=mean(sep27(:,3));
    sep27std=std(sep27(:,3));
    temp=[a sep27mean sep27std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<272);
sep28=data(k,:);
data(k,:)=[];
if length(sep28)>0
    sep28mean=mean(sep28(:,3));
    sep28std=std(sep28(:,3));
    temp=[a sep28mean sep28std];
    stats=[stats;temp];
end
a=a+1;
```

```
k=find(data(:,1)<273);
sep29=data(k,:);
data(k,:)=[];
if length(sep29)>0
   sep29mean=mean(sep29(:,3));
   sep29std=std(sep29(:,3));
   temp=[a sep29mean sep29std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<274);
sep30=data(k,:);
data(k,:)=[];
if length(sep30)>0
   sep30mean=mean(sep30(:,3));
   sep30std=std(sep30(:,3));
   temp=[a sep30mean sep30std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<275);
oct1=data(k,:);
data(k,:)=[];
if length(oct1)>0
   oct1mean=mean(oct1(:,3));
   oct1std=std(oct1(:,3));
   temp=[a oct1mean oct1std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<276);
oct2=data(k,:);
data(k,:)=[];
if length(oct2)>0
   oct2mean=mean(oct2(:,3));
   oct2std=std(oct2(:,3));
   temp=[a oct2mean oct2std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<277);
oct3=data(k,:);
data(k,:)=[];
if length(oct3)>0
   oct3mean=mean(oct3(:,3));
   oct3std=std(oct3(:,3));
```

```
    temp=[a oct3mean oct3std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<278);
oct4=data(k,:);
data(k,:)=[];
if length(oct4)>0
    oct4mean=mean(oct4(:,3));
    oct4std=std(oct4(:,3));
    temp=[a oct4mean oct4std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<279);
oct5=data(k,:);
data(k,:)=[];
if length(oct5)>0
    oct5mean=mean(oct5(:,3));
    oct5std=std(oct5(:,3));
    temp=[a oct5mean oct5std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<280);
oct6=data(k,:);
data(k,:)=[];
if length(oct6)>0
    oct6mean=mean(oct6(:,3));
    oct6std=std(oct6(:,3));
    temp=[a oct6mean oct6std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<281);
oct7=data(k,:);
data(k,:)=[];
if length(oct7)>0
    oct7mean=mean(oct7(:,3));
    oct7std=std(oct7(:,3));
    temp=[a oct7mean oct7std];
    stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<282);
```

```
oct8=data(k,:);
data(k,:)=[];
if length(oct8)>0
   oct8mean=mean(oct8(:,3));
   oct8std=std(oct8(:,3));
   temp=[a oct8mean oct8std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<283);
oct9=data(k,:);
data(k,:)=[];
if length(oct9)>0
   oct9mean=mean(oct9(:,3));
   oct9std=std(oct9(:,3));
   temp=[a oct9mean oct9std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<284);
oct10=data(k,:);
data(k,:)=[];
if length(oct10)>0
   oct10mean=mean(oct10(:,3));
   oct10std=std(oct10(:,3));
   temp=[a oct10mean oct10std];
   stats=[stats;temp];
end
a=a+1;

k=find(data(:,1)<285);
oct11=data(k,:);
data(k,:)=[];
if length(oct11)>0
   oct11mean=mean(oct11(:,3));
   oct11std=std(oct11(:,3));
   temp=[a oct11mean oct11std];
   stats=[stats;temp];
end
a=a+1;

clear data a*m* a*s* s*m* s*std o*m* o*s* a
```

dayspeed.m

```
j=1;

dtime=(day(2:end,1)-day(1:end-1,1))*86400;

while j<length(day)
   x1=day(j,2);
   y1=day(j,3);
   z1=day(j,4);

   x2=day(j+1,2);
   y2=day(j+1,3);
   z2=day(j+1,4);

   x=x2-x1;
   y=y2-y1;
   z=z2-z1;

   ddist(j,1)=sqrt((x.^2)+(y.^2)+(z.^2));
   j=j+1;
end

r=1;
while r<=length(dtime)
   dspeed(r,1)=ddist(r,1)/dtime(r,1);
   r=r+1;
end

dbodylengths=dspeed/forklength;

clear x* y* z* j r
```

depthvar.m

```
%This routine calculates the mean and variance of the depth distribution of
%the fish on a given day and saves them as individual variables.

k=find(data(:,2)<217);
temp=data(k,:);
l=length(temp);
if l>1
   mean0804=mean(temp(:,3));
   var0804=var(temp(:,3));
else
   mean0804=NaN;
   var0804=NaN;
end
data(k,:)=[];

k=find(data(:,2)<218);
temp=data(k,:);
l=length(temp);
if l>1
   mean0805=mean(temp(:,3));
   var0805=var(temp(:,3));
else
   mean0805=NaN;
   var0805=NaN;
end
data(k,:)=[];

k=find(data(:,2)<219);
temp=data(k,:);
l=length(temp);
if l>1
   mean0806=mean(temp(:,3));
   var0806=var(temp(:,3));
else
   mean0806=NaN;
   var0806=NaN;
end
data(k,:)=[];

k=find(data(:,2)<220);
temp=data(k,:);
l=length(temp);
if l>1
   mean0807=mean(temp(:,3));
   var0807=var(temp(:,3));
else
   mean0807=NaN;
   var0807=NaN;
```

```
end
data(k,:)=[];

k=find(data(:,2)<221);
temp=data(k,:);
l=length(temp);
if l>1
   mean0808=mean(temp(:,3));
   var0808=var(temp(:,3));
else
   mean0808=NaN;
   var0808=NaN;
end
data(k,:)=[];

k=find(data(:,2)<222);
temp=data(k,:);
l=length(temp);
if l>1
   mean0809=mean(temp(:,3));
   var0809=var(temp(:,3));
else
   mean0809=NaN;
   var0809=NaN;
end
data(k,:)=[];

k=find(data(:,2)<223);
temp=data(k,:);
l=length(temp);
if l>1
   mean0810=mean(temp(:,3));
   var0810=var(temp(:,3));
else
   mean0810=NaN;
   var0810=NaN;
end
data(k,:)=[];

k=find(data(:,2)<224);
temp=data(k,:);
l=length(temp);
if l>1
   mean0811=mean(temp(:,3));
   var0811=var(temp(:,3));
else
   mean0811=NaN;
   var0811=NaN;
end
data(k,:)=[];
```

```
k=find(data(:,2)<225);
temp=data(k,:);
l=length(temp);
if l>1
   mean0812=mean(temp(:,3));
   var0812=var(temp(:,3));
else
   mean0812=NaN;
   var0812=NaN;
end
data(k,:)=[];

k=find(data(:,2)<226);
temp=data(k,:);
l=length(temp);
if l>1
   mean0813=mean(temp(:,3));
   var0813=var(temp(:,3));
else
   mean0813=NaN;
   var0813=NaN;
end
data(k,:)=[];

k=find(data(:,2)<227);
temp=data(k,:);
l=length(temp);
if l>1
   mean0814=mean(temp(:,3));
   var0814=var(temp(:,3));
else
   mean0814=NaN;
   var0814=NaN;
end
data(k,:)=[];

k=find(data(:,2)<228);
temp=data(k,:);
l=length(temp);
if l>1
   mean0815=mean(temp(:,3));
   var0815=var(temp(:,3));
else
   mean0815=NaN;
   var0815=NaN;
end
data(k,:)=[];

k=find(data(:,2)<229);
```

```
temp=data(k,:);
l=length(temp);
if l>1
   mean0816=mean(temp(:,3));
   var0816=var(temp(:,3));
else
   mean0816=NaN;
   var0816=NaN;
end
data(k,:)=[];

k=find(data(:,2)<230);
temp=data(k,:);
l=length(temp);
if l>1
   mean0817=mean(temp(:,3));
   var0817=var(temp(:,3));
else
   mean0817=NaN;
   var0817=NaN;
end
data(k,:)=[];

k=find(data(:,2)<231);
temp=data(k,:);
l=length(temp);
if l>1
   mean0818=mean(temp(:,3));
   var0818=var(temp(:,3));
else
   mean0818=NaN;
   var0818=NaN;
end
data(k,:)=[];

k=find(data(:,2)<232);
temp=data(k,:);
l=length(temp);
if l>1
   mean0819=mean(temp(:,3));
   var0819=var(temp(:,3));
else
   mean0819=NaN;
   var0819=NaN;
end
data(k,:)=[];

k=find(data(:,2)<233);
temp=data(k,:);
l=length(temp);
```

```
if l>1
   mean0820=mean(temp(:,3));
   var0820=var(temp(:,3));
else
   mean0820=NaN;
   var0820=NaN;
end
data(k,:)=[];

k=find(data(:,2)<234);
temp=data(k,:);
l=length(temp);
if l>1
   mean0821=mean(temp(:,3));
   var0821=var(temp(:,3));
else
   mean0821=NaN;
   var0821=NaN;
end
data(k,:)=[];

k=find(data(:,2)<235);
temp=data(k,:);
l=length(temp);
if l>1
   mean0822=mean(temp(:,3));
   var0822=var(temp(:,3));
else
   mean0822=NaN;
   var0822=NaN;
end
data(k,:)=[];

k=find(data(:,2)<236);
temp=data(k,:);
l=length(temp);
if l>1
   mean0823=mean(temp(:,3));
   var0823=var(temp(:,3));
else
   mean0823=NaN;
   var0823=NaN;
end
data(k,:)=[];

k=find(data(:,2)<237);
temp=data(k,:);
l=length(temp);
if l>1
   mean0824=mean(temp(:,3));
```

```
    var0824=var(temp(:,3));
else
    mean0824=NaN;
    var0824=NaN;
end
data(k,:)=[];

k=find(data(:,2)<238);
temp=data(k,:);
l=length(temp);
if l>1
    mean0825=mean(temp(:,3));
    var0825=var(temp(:,3));
else
    mean0825=NaN;
    var0825=NaN;
end
data(k,:)=[];

k=find(data(:,2)<239);
temp=data(k,:);
l=length(temp);
if l>1
    mean0826=mean(temp(:,3));
    var0826=var(temp(:,3));
else
    mean0826=NaN;
    var0826=NaN;
end
data(k,:)=[];

clear k l temp data
```

dist3d.m

```
data=[br29500 br30100 br30200 br30500 br30600 br30800 br31200 br31300 ...
br31400 br31500 br31600 br31800 br32100 br32300 br32400 br32500 ...
br32700 br32900 br33000 br33200 br33300 br33500 br33600 br33700 ...
br33800 br34000 br34200 br34300 br34600 br34800 br34900 br35000];

a=2;
i=6;
j=7;
k=8;

if data(1,2)==9999
   dist29500=br29500(:,1);
   dist29500(1:17280,2:32)=NaN;
else
   while i<129 %data should have 128 columns
      if data(1,2)~=9999 %if there is data for 29500
         dist29500(:,1)=(2:5:86397)';
         x1=data(:,2); %create a column of x-values
         y1=data(:,3); %create a column of y-values
         z1=data(:,4); %create a column of depth values
      end

      if data(1,i)~=9999 %if data exists for other fish
         x2=data(:,i); %create a column of x-values
         y2=data(:,j); %create a column of y-values
         z2=data(:,k); %create a column of depth values
         i=i+4; %increment counters to next fish
         j=j+4;
         k=k+4;
         %The calculation of 3d euclidean distance is
         %sqrt((x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2)
         %This calculation needs to be done in steps
         x=x1-x2; %Do the x1-x2 calculation
         y=y1-y2; %do the y1-y2 calculation
         z=z1-z2; %Do the z1-z2 calculation

         dist=sqrt((x.^2)+(y.^2)+(z.^2)); %calculate euclidean distance

         dist29500(:,a)=dist; %assign the calculated distances to the
                              %first column of the variable
         a=a+1; %increment counter to next column of distances
      else
         dist29500(1:17280,a)=NaN; %if no data for next fish assign a
                                   %column of NaNs to variable
         i=i+4; %increment counters to next fish
         j=j+4;
         k=k+4;
         a=a+1;
```

```
        end
    end
end
k=(dist29500(:,1:32)==0);
dist29500(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=10; %begin calculations with the third fish
j=11;
k=12;

if data(1,6)==9999
    dist30100=br30100(:,1);
    dist30100(1:17280,2:31)=NaN;
else
    while i<129
        if data(1,6)~=9999
            dist30100(:,1)=((2:5:86397))';
            x1=data(:,6);
            y1=data(:,7);
            z1=data(:,8);
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist30100(:,a)=dist;
            a=a+1;
        else
            dist30100(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist30100(:,1:31)==0);
```

```
dist30100(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=14;
j=15;
k=16;

if data(1,10)==9999
   dist30200=br30200(:,1);
   dist30200(1:17280,2:30)=NaN;
else
   while i<129
      if data(1,10)~=9999
         dist30200(:,1)=((2:5:86397))';
         x1=data(:,10);
         y1=data(:,11);
         z1=data(:,12);
      end

      if data(1,i)~=9999
        x2=data(:,i);
        y2=data(:,j);
        z2=data(:,k);
        i=i+4;
        j=j+4;
        k=k+4;

         x=x1-x2;
         y=y1-y2;
         z=z1-z2;

         dist=sqrt((x.^2)+(y.^2)+(z.^2));

         dist30200(:,a)=dist;
         a=a+1;
      else
        dist30200(1:17280,a)=NaN;
        i=i+4;
        j=j+4;
        k=k+4;
        a=a+1;
      end
   end
end
k=(dist30200(:,1:30)==0);
dist30200(k)=NaN;
clear x* y* z* i j k a dist

a=2;
```

```
i=18;
j=19;
k=20;

if data(1,14)==9999
    dist30500=br30500(:,1);
    dist30500(1:17280,2:29)=NaN;
else
    while i<129
        if data(1,14)~=9999
          dist30500(:,1)=((2:5:86397))';
          x1=data(:,14);
          y1=data(:,15);
          z1=data(:,16);
        end

        if data(1,i)~=9999
          x2=data(:,i);
          y2=data(:,j);
          z2=data(:,k);
          i=i+4;
          j=j+4;
          k=k+4;

           x=x1-x2;
           y=y1-y2;
           z=z1-z2;

           dist=sqrt((x.^2)+(y.^2)+(z.^2));

           dist30500(:,a)=dist;
           a=a+1;
        else
          dist30500(1:17280,a)=NaN;
          i=i+4;
          j=j+4;
          k=k+4;
          a=a+1;
        end
    end
end
k=(dist30500(:,1:29)==0);
dist30500(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=22;
j=23;
k=24;
```

```
if data(1,18)==9999
   dist30600=br30600(:,1);
   dist30600(1:17280,2:28)=NaN;
else
   while i<129
      if data(1,18)~=9999
         dist30600(:,1)=((2:5:86397))';
         x1=data(:,18);
         y1=data(:,19);
         z1=data(:,20);
      end

      if data(1,i)~=9999
         x2=data(:,i);
         y2=data(:,j);
         z2=data(:,k);
         i=i+4;
         j=j+4;
         k=k+4;

         x=x1-x2;
         y=y1-y2;
         z=z1-z2;

         dist=sqrt((x.^2)+(y.^2)+(z.^2));

         dist30600(:,a)=dist;
         a=a+1;
      else
         dist30600(1:17280,a)=NaN;
         i=i+4;
         j=j+4;
         k=k+4;
         a=a+1;
      end
   end
end
k=(dist30600(:,1:28)==0);
dist30600(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=26;
j=27;
k=28;

if data(1,22)==9999
   dist30800=br30800(:,1);
   dist30800(1:17280,2:27)=NaN;
else
```

```
    while i<129
        if data(1,22)~=9999
            dist30800(:,1)=((2:5:86397))';
            x1=data(:,22);
            y1=data(:,23);
            z1=data(:,24);
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist30800(:,a)=dist;
            a=a+1;
        else
            dist30800(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist30800(:,1:27)==0);
dist30800(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=30;
j=31;
k=32;

if data(1,26)==9999
    dist31200=br31200(:,1);
    dist31200(1:17280,2:26)=NaN;
else
    while i<129
        if data(1,26)~=9999
            dist31200(:,1)=((2:5:86397))';
            x1=data(:,26);
```

```
      y1=data(:,27);
      z1=data(:,28);
    end

    if data(1,i)~=9999
      x2=data(:,i);
      y2=data(:,j);
      z2=data(:,k);
      i=i+4;
      j=j+4;
      k=k+4;

      x=x1-x2;
      y=y1-y2;
      z=z1-z2;

      dist=sqrt((x.^2)+(y.^2)+(z.^2));

      dist31200(:,a)=dist;
      a=a+1;
    else
      dist31200(1:17280,a)=NaN;
      i=i+4;
      j=j+4;
      k=k+4;
      a=a+1;
    end

  end
end
k=(dist31200(:,1:26)==0);
dist31200(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=34;
j=35;
k=36;

if data(1,30)==9999
  dist31300=br31300(:,1);
  dist31300(1:17280,2:25)=NaN;
else
  while i<129
    if data(1,30)~=9999
      dist31300(:,1)=((2:5:86397))';
      x1=data(:,30);
      y1=data(:,31);
      z1=data(:,32);
    end
```

```
        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist31300(:,a)=dist;
            a=a+1;
        else
            dist31300(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist31300(:,1:25)==0);
dist31300(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=38;
j=39;
k=40;

if data(1,34)==9999
    dist31400=br31400(:,1);
    dist31400(1:17280,2:24)=NaN;
else
    while i<129
        if data(1,34)~=9999
            dist31400(:,1)=((2:5:86397))';
            x1=data(:,34);
            y1=data(:,35);
            z1=data(:,36);
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
```

```
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist31400(:,a)=dist;
            a=a+1;
         else
            dist31400(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
         end
      end
   end
   k=(dist31400(:,1:24)==0);
   dist31400(k)=NaN;
   clear x* y* z* i j k a dist

   a=2;
   i=42;
   j=43;
   k=44;

   if data(1,38)==9999
      dist31500=br31500(:,1);
      dist31500(1:17280,2:23)=NaN;
   else
      while i<129
         if data(1,38)~=9999
            dist31500(:,1)=((2:5:86397))';
            x1=data(:,38);
            y1=data(:,39);
            z1=data(:,40);
         end

         if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;
```

```
            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist31500(:,a)=dist;
            a=a+1;
        else
            dist31500(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist31500(:,1:23)==0);
dist31500(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=46;
j=47;
k=48;

if data(1,42)==9999
    dist31600=br31600(:,1);
    dist31600(1:17280,2:22)=NaN;
else
    while i<129
        if data(1,42)~=9999
            dist31600(:,1)=((2:5:86397))';
            x1=data(:,42);
            y1=data(:,43);
            z1=data(:,44);
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;
```

```
            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist31600(:,a)=dist;
            a=a+1;
        else
            dist31600(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist31600(:,1:22)==0);
dist31600(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=50;
j=51;
k=52;

if data(1,46)==9999
    dist31800=br31800(:,1);
    dist31800(1:17280,2:21)=NaN;
else
    while i<129
        if data(1,46)~=9999
            dist31800(:,1)=((2:5:86397))';
            x1=data(:,46);
            y1=data(:,47);
            z1=data(:,48);
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist31800(:,a)=dist;
```

```
            a=a+1;
        else
            dist31800(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist31800(:,1:21)==0);
dist31800(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=54;
j=55;
k=56;

if data(1,50)==9999
    dist32100=br32100(:,1);
    dist32100(1:17280,2:20)=NaN;
else
    while i<129
        if data(1,50)~=9999
            dist32100(:,1)=(2:5:86397)';
            x1=data(:,50);
            y1=data(:,51);
            z1=data(:,52);
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist32100(:,a)=dist;
            a=a+1;
        else
            dist32100(1:17280,a)=NaN;
            i=i+4;
```

```
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist32100(:,1:20)==0);
dist32100(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=58;
j=59;
k=60;

if data(1,54)==9999
    dist32300=br32300(:,1);
    dist32300(1:17280,2:19)=NaN;
else
    while i<129
        if data(1,54)~=9999
            dist32300(:,1)=((2:5:86397))';
            x1=data(:,54);
            y1=data(:,55);
            z1=data(:,56);
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist32300(:,a)=dist;
            a=a+1;
        else
            dist32300(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
```

```
    end
end
k=(dist32300(:,1:19)==0);
dist32300(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=62;
j=63;
k=64;

if data(1,58)==9999
    dist32400=br32400(:,1);
    dist32400(1:17280,2:18)=NaN;
else
    while i<129
        if data(1,58)~=9999
            dist32400(:,1)=((2:5:86397))';
            x1=data(:,58);
            y1=data(:,59);
            z1=data(:,60);
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist32400(:,a)=dist;
            a=a+1;
        else
            dist32400(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist32400(:,1:18)==0);
dist32400(k)=NaN;
```

```
clear x* y* z* i j k a dist

a=2;
i=66;
j=67;
k=68;

if data(1,62)==9999
   dist32500=br32500(:,1);
   dist32500(1:17280,2:17)=NaN;
else
   while i<129
      if data(1,62)~=9999
         dist32500(:,1)=((2:5:86397))';
         x1=data(:,62);
         y1=data(:,63);
         z1=data(:,64);
      end

      if data(1,i)~=9999
         x2=data(:,i);
         y2=data(:,j);
         z2=data(:,k);
         i=i+4;
         j=j+4;
         k=k+4;

         x=x1-x2;
         y=y1-y2;
         z=z1-z2;

         dist=sqrt((x.^2)+(y.^2)+(z.^2));

         dist32500(:,a)=dist;
         a=a+1;
      else
         dist32500(1:17280,a)=NaN;
         i=i+4;
         j=j+4;
         k=k+4;
         a=a+1;
      end
   end
end
k=(dist32500(:,1:17)==0);
dist32500(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=70;
```

```
j=71;
k=72;

if data(1,66)==9999
   dist32700=br32700(:,1);
   dist32700(1:17280,2:16)=NaN;
else
   while i<129
      if data(1,66)~=9999
         dist32700(:,1)=((2:5:86397))';
         x1=data(:,66);
         y1=data(:,67);
         z1=data(:,68);
      end

      if data(1,i)~=9999
         x2=data(:,i);
         y2=data(:,j);
         z2=data(:,k);
         i=i+4;
         j=j+4;
         k=k+4;

         x=x1-x2;
         y=y1-y2;
         z=z1-z2;

         dist=sqrt((x.^2)+(y.^2)+(z.^2));

         dist32700(:,a)=dist;
         a=a+1;
      else
         dist32700(1:17280,a)=NaN;
         i=i+4;
         j=j+4;
         k=k+4;
         a=a+1;
      end
   end
end
k=(dist32700(:,1:16)==0);
dist32700(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=74;
j=75;
k=76;

if data(1,70)==9999
```

```
    dist32900=br32900(:,1);
    dist32900(1:17280,2:15)=NaN;
else
    while i<129
        if data(1,70)~=9999
            dist32900(:,1)=((2:5:86397))';
            x1=data(:,70);
            y1=data(:,71);
            z1=data(:,72);
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist32900(:,a)=dist;
            a=a+1;
        else
            dist32900(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist32900(:,1:15)==0);
dist32900(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=78;
j=79;
k=80;

if data(1,74)==9999
    dist33000=br33000(:,1);
    dist33000(1:17280,2:14)=NaN;
else
    while i<129
```

```
        if data(1,74)~=9999
           dist33000(:,1)=((2:5:86397))';
           x1=data(:,74);
           y1=data(:,75);
           z1=data(:,76);
        end

        if data(1,i)~=9999
           x2=data(:,i);
           y2=data(:,j);
           z2=data(:,k);
           i=i+4;
           j=j+4;
           k=k+4;

           x=x1-x2;
           y=y1-y2;
           z=z1-z2;

           dist=sqrt((x.^2)+(y.^2)+(z.^2));

           dist33000(:,a)=dist;
           a=a+1;
        else
           dist33000(1:17280,a)=NaN;
           i=i+4;
           j=j+4;
           k=k+4;
           a=a+1;
        end
    end
end
k=(dist33000(:,1:14)==0);
dist33000(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=82;
j=83;
k=84;

if data(1,78)==9999
    dist33200=br33200(:,1);
    dist33200(1:17280,2:13)=NaN;
else
    while i<129
        if data(1,78)~=9999
           dist33200(:,1)=((2:5:86397))';
           x1=data(:,78);
           y1=data(:,79);
```

```
            z1=data(:,80);
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist33200(:,a)=dist;
            a=a+1;
        else
            dist33200(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist33200(:,1:13)==0);
dist33200(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=86;
j=87;
k=88;

if data(1,82)==9999
    dist33300=br33300(:,1);
    dist33300(1:17280,2:12)=NaN;
else
    while i<129
        if data(1,82)~=9999
            dist33300(:,1)=((2:5:86397))';
            x1=data(:,82);
            y1=data(:,83);
            z1=data(:,84);
        else
            dist33300=[];
        end
```

```
        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist33300(:,a)=dist;
            a=a+1;
        else
            dist33300(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist33300(:,1:12)==0);
dist33300(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=90;
j=91;
k=92;

if data(1,86)==9999
    dist33500=br33500(:,1);
    dist33500(1:17280,11)=NaN;
else
    while i<129
        if data(1,86)~=9999
            dist33500(:,1)=((2:5:86397))';
            x1=data(:,86);
            y1=data(:,87);
            z1=data(:,88);
        else
            dist33500=[];
        end

        if data(1,i)~=9999
```

```
      x2=data(:,i);
      y2=data(:,j);
      z2=data(:,k);
      i=i+4;
      j=j+4;
      k=k+4;

      x=x1-x2;
      y=y1-y2;
      z=z1-z2;

      dist=sqrt((x.^2)+(y.^2)+(z.^2));

      dist33500(:,a)=dist;
      a=a+1;
    else
      dist33500(1:17280,a)=NaN;
      i=i+4;
      j=j+4;
      k=k+4;
      a=a+1;
    end
  end
end
k=(dist33500(:,1:11)==0);
dist33500(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=94;
j=95;
k=96;

if data(1,90)==9999
  dist33600=br33600(:,1);
  dist33600(1:17280,10)=NaN;
else
  while i<129
    if data(1,90)~=9999
      dist33600(:,1)=((2:5:86397))';
      x1=data(:,90);
      y1=data(:,91);
      z1=data(:,92);
    else
      dist33600=[];
    end

    if data(1,i)~=9999
      x2=data(:,i);
      y2=data(:,j);
```

```
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist33600(:,a)=dist;
            a=a+1;
        else
            dist33600(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist33600(:,1:10)==0);
dist33600(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=98;
j=99;
k=100;

if data(1,94)==9999
    dist33700=br33700(:,1);
    dist33700(1:17280,9)=NaN;
else
    while i<129
        if data(1,94)~=9999
            dist33700(:,1)=((2:5:86397))';
            x1=data(:,94);
            y1=data(:,95);
            z1=data(:,96);
        else
            dist33700=[];
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
```

```
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist33700(:,a)=dist;
            a=a+1;
        else
            dist33700(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist33700(:,1:9)==0);
dist33700(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=102;
j=103;
k=104;

if data(1,98)==9999
    dist33800=br33800(:,1);
    dist33800(1:17280,8)=NaN;
else
    while i<129
        if data(1,98)~=9999
            dist33800(:,1)=((2:5:86397))';
            x1=data(:,98);
            y1=data(:,99);
            z1=data(:,100);
        else
            dist33800=[];
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;
```

```
            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist33800(:,a)=dist;
            a=a+1;
        else
            dist33800(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist33800(:,1:8)==0);
dist33800(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=106;
j=107;
k=108;

if data(1,102)==9999
    dist34000=br34000(:,1);
    dist34000(1:17280,7)=NaN;
else
    while i<129
        if data(1,102)~=9999
            dist34000(:,1)=((2:5:86397))';
            x1=data(:,102);
            y1=data(:,103);
            z1=data(:,104);
        else
            dist34000=[];
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
```

```
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist34000(:,a)=dist;
            a=a+1;
        else
            dist34000(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist34000(:,1:7)==0);
dist34000(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=110;
j=111;
k=112;

if data(1,106)==9999
    dist34200=br34200(:,1);
    dist34200(1:17280,6)=NaN;
else
    while i<129
        if data(1,106)~=9999
            dist34200(:,1)=((2:5:86397))';
            x1=data(:,106);
            y1=data(:,107);
            z1=data(:,108);
        else
            dist34200=[];
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;
```

```
            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist34200(:,a)=dist;
            a=a+1;
         else
            dist34200(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
         end
      end
   end
   k=(dist34200(:,1:6)==0);
   dist34200(k)=NaN;
   clear x* y* z* i j k a dist

   a=2;
   i=114;
   j=115;
   k=116;

   if data(1,110)==9999
      dist34300=br34300(:,1);
      dist34300(1:17280,5)=NaN;
   else
      while i<129
         if data(1,110)~=9999
            dist34300(:,1)=((2:5:86397))';
            x1=data(:,110);
            y1=data(:,111);
            z1=data(:,112);
         else
            dist34300=[];
         end

         if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));
```

```
            dist34300(:,a)=dist;
            a=a+1;
        else
            dist34300(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist34300(:,1:5)==0);
dist34300(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=118;
j=119;
k=120;

if data(1,114)==9999
    dist34600=br34600(:,1);
    dist34600(1:17280,4)=NaN;
else
    while i<129
        if data(1,114)~=9999
            dist34600(:,1)=((2:5:86397))';
            x1=data(:,114);
            y1=data(:,115);
            z1=data(:,116);
        else
            dist34600=[];
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist34600(:,a)=dist;
```

```
            a=a+1;
        else
            dist34600(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist34600(:,1:4)==0);
dist34600(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=122;
j=123;
k=124;

if data(1,118)==9999
    dist34800=br34800(:,1);
    dist34800(1:17280,3)=NaN;
else
    while i<129
        if data(1,118)~=9999
            dist34800(:,1)=((2:5:86397))';
            x1=data(:,118);
            y1=data(:,119);
            z1=data(:,120);
        else
            dist34800=[];
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist34800(:,a)=dist;
            a=a+1;
        else
```

```
            dist34800(1:17280,a)=NaN;
            i=i+4;
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist34800(:,1:3)==0);
dist34800(k)=NaN;
clear x* y* z* i j k a dist

a=2;
i=126;
j=127;
k=128;

if data(1,122)==9999
    dist34900=br34900(:,1);
    dist34900(1:17280,2)=NaN;
else
    while i<129
        if data(1,122)~=9999
            dist34900(:,1)=((2:5:86397))';
            x1=data(:,122);
            y1=data(:,123);
            z1=data(:,124);
        else
            dist34900=[];
        end

        if data(1,i)~=9999
            x2=data(:,i);
            y2=data(:,j);
            z2=data(:,k);
            i=i+4;
            j=j+4;
            k=k+4;

            x=x1-x2;
            y=y1-y2;
            z=z1-z2;

            dist=sqrt((x.^2)+(y.^2)+(z.^2));

            dist34900(:,a)=dist;
            a=a+1;
        else
            dist34900(1:17280,a)=NaN;
            i=i+4;
```

```
            j=j+4;
            k=k+4;
            a=a+1;
        end
    end
end
k=(dist34900(:,1:2)==0);
dist34900(k)=NaN;
clear x* y* z* i j k a dist

dist30100=[dist30100(:,1) dist29500(:,2) dist30100(:,2:31)];

dist30200=[dist30200(:,1) dist29500(:,3) dist30100(:,3) dist30200(:,2:30)];

dist30500=[dist30500(:,1) dist29500(:,4) dist30100(:,4) dist30200(:,4)...
    dist30500(:,2:29)];

dist30600=[dist30600(:,1) dist29500(:,5) dist30100(:,5) dist30200(:,5)...
    dist30500(:,5) dist30600(:,2:28)];

dist30800=[dist30800(:,1) dist29500(:,6) dist30100(:,6) dist30200(:,6)...
    dist30500(:,6) dist30600(:,6) dist30800(:,2:27)];

dist31200=[dist31200(:,1) dist29500(:,7) dist30100(:,7) dist30200(:,7)...
    dist30500(:,7) dist30600(:,7) dist30800(:,7) dist31200(:,2:26)];

dist31300=[dist31300(:,1) dist29500(:,8) dist30100(:,8) dist30200(:,8)...
    dist30500(:,8) dist30600(:,8) dist30800(:,8) dist31200(:,8)...
    dist31300(:,2:25)];

dist31400=[dist31400(:,1) dist29500(:,9) dist30100(:,9) dist30200(:,9)...
    dist30500(:,9) dist30600(:,9) dist30800(:,9) dist31200(:,9)...
    dist31300(:,9) dist31400(:,2:24)];

dist31500=[dist31500(:,1) dist29500(:,10) dist30100(:,10) dist30200(:,10)...
    dist30500(:,10) dist30600(:,10) dist30800(:,10) dist31200(:,10)...
    dist31300(:,10) dist31400(:,10) dist31500(:,2:23)];

dist31600=[dist31600(:,1) dist29500(:,11) dist30100(:,11) dist30200(:,11)...
    dist30500(:,11) dist30600(:,11) dist30800(:,11) dist31200(:,11)...
    dist31300(:,11) dist31400(:,11) dist31500(:,11) dist31600(:,2:22)];

dist31800=[dist31800(:,1) dist29500(:,12) dist30100(:,12) dist30200(:,12)...
    dist30500(:,12) dist30600(:,12) dist30800(:,12) dist31200(:,12)...
    dist31300(:,12) dist31400(:,12) dist31500(:,12) dist31600(:,12)...
    dist31800(:,2:21)];

dist32100=[dist32100(:,1) dist29500(:,13) dist30100(:,13) dist30200(:,13)...
    dist30500(:,13) dist30600(:,13) dist30800(:,13) dist31200(:,13)...
    dist31300(:,13) dist31400(:,13) dist31500(:,13) dist31600(:,13)...
```

```
    dist31800(:,13) dist32100(:,2:20)];

dist32300=[dist32300(:,1) dist29500(:,14) dist30100(:,14) dist30200(:,14)...
    dist30500(:,14) dist30600(:,14) dist30800(:,14) dist31200(:,14)...
    dist31300(:,14) dist31400(:,14) dist31500(:,14) dist31600(:,14)...
    dist31800(:,14) dist32100(:,14) dist32300(:,2:19)];

dist32400=[dist32400(:,1) dist29500(:,15) dist30100(:,15) dist30200(:,15)...
    dist30500(:,15) dist30600(:,15) dist30800(:,15) dist31200(:,15)...
    dist31300(:,15) dist31400(:,15) dist31500(:,15) dist31600(:,15)...
    dist31800(:,15) dist32100(:,15) dist32300(:,15) dist32400(:,2:18)];

dist32500=[dist32500(:,1) dist29500(:,16) dist30100(:,16) dist30200(:,16)...
    dist30500(:,16) dist30600(:,16) dist30800(:,16) dist31200(:,16)...
    dist31300(:,16) dist31400(:,16) dist31500(:,16) dist31600(:,16)...
    dist31800(:,16) dist32100(:,16) dist32300(:,16) dist32400(:,16)...
    dist32500(:,2:17)];

dist32700=[dist32700(:,1) dist29500(:,17) dist30100(:,17) dist30200(:,17)...
    dist30500(:,17) dist30600(:,17) dist30800(:,17) dist31200(:,17)...
    dist31300(:,17) dist31400(:,17) dist31500(:,17) dist31600(:,17)...
    dist31800(:,17) dist32100(:,17) dist32300(:,17) dist32400(:,17)...
    dist32500(:,17) dist32700(:,2:16)];

dist32900=[dist32900(:,1) dist29500(:,18) dist30100(:,18) dist30200(:,18)...
    dist30500(:,18) dist30600(:,18) dist30800(:,18) dist31200(:,18)...
    dist31300(:,18) dist31400(:,18) dist31500(:,18) dist31600(:,18)...
    dist31800(:,18) dist32100(:,18) dist32300(:,18) dist32400(:,18)...
    dist32500(:,18) dist32700(:,18) dist32900(:,2:15)];

dist33000=[dist33000(:,1) dist29500(:,19) dist30100(:,19) dist30200(:,19)...
    dist30500(:,19) dist30600(:,19) dist30800(:,19) dist31200(:,19)...
    dist31300(:,19) dist31400(:,19) dist31500(:,19) dist31600(:,19)...
    dist31800(:,19) dist32100(:,19) dist32300(:,19) dist32400(:,19)...
    dist32500(:,19) dist32700(:,19) dist32900(:,19) dist33000(:,2:14)];

dist33200=[dist33200(:,1) dist29500(:,20) dist30100(:,20) dist30200(:,20)...
    dist30500(:,20) dist30600(:,20) dist30800(:,20) dist31200(:,20)...
    dist31300(:,20) dist31400(:,20) dist31500(:,20) dist31600(:,20)...
    dist31800(:,20) dist32100(:,20) dist32300(:,20) dist32400(:,20)...
    dist32500(:,20) dist32700(:,20) dist32900(:,20) dist33000(:,20)...
    dist33200(:,2:13)];

dist33300=[dist33300(:,1) dist29500(:,21) dist30100(:,21) dist30200(:,21)...
    dist30500(:,21) dist30600(:,21) dist30800(:,21) dist31200(:,21)...
    dist31300(:,21) dist31400(:,21) dist31500(:,21) dist31600(:,21)...
    dist31800(:,21) dist32100(:,21) dist32300(:,21) dist32400(:,21)...
    dist32500(:,21) dist32700(:,21) dist32900(:,21) dist33000(:,21)...
    dist33200(:,21) dist33300(:,2:12)];
```

```
dist33500=[dist33500(:,1) dist29500(:,22) dist30100(:,22) dist30200(:,22)...
   dist30500(:,22) dist30600(:,22) dist30800(:,22) dist31200(:,22)...
   dist31300(:,22) dist31400(:,22) dist31500(:,22) dist31600(:,22)...
   dist31800(:,22) dist32100(:,22) dist32300(:,22) dist32400(:,22)...
   dist32500(:,22) dist32700(:,22) dist32900(:,22) dist33000(:,22)...
   dist33200(:,22) dist33300(:,22) dist33500(:,2:11)];

dist33600=[dist33600(:,1) dist29500(:,23) dist30100(:,23) dist30200(:,23)...
   dist30500(:,23) dist30600(:,23) dist30800(:,23) dist31200(:,23)...
   dist31300(:,23) dist31400(:,23) dist31500(:,23) dist31600(:,23)...
   dist31800(:,23) dist32100(:,23) dist32300(:,23) dist32400(:,23)...
   dist32500(:,23) dist32700(:,23) dist32900(:,23) dist33000(:,23)...
   dist33200(:,23) dist33300(:,23) dist33500(:,23) dist33600(:,2:10)];

dist33700=[dist33700(:,1) dist29500(:,24) dist30100(:,24) dist30200(:,24)...
   dist30500(:,24) dist30600(:,24) dist30800(:,24) dist31200(:,24)...
   dist31300(:,24) dist31400(:,24) dist31500(:,24) dist31600(:,24)...
   dist31800(:,24) dist32100(:,24) dist32300(:,24) dist32400(:,24)...
   dist32500(:,24) dist32700(:,24) dist32900(:,24) dist33000(:,24)...
   dist33200(:,24) dist33300(:,24) dist33500(:,24) dist33600(:,24)...
   dist33700(:,2:9)];

dist33800=[dist33800(:,1) dist29500(:,25) dist30100(:,25) dist30200(:,25)...
   dist30500(:,25) dist30600(:,25) dist30800(:,25) dist31200(:,25)...
   dist31300(:,25) dist31400(:,25) dist31500(:,25) dist31600(:,25)...
   dist31800(:,25) dist32100(:,25) dist32300(:,25) dist32400(:,25)...
   dist32500(:,25) dist32700(:,25) dist32900(:,25) dist33000(:,25)...
   dist33200(:,25) dist33300(:,25) dist33500(:,25) dist33600(:,25)...
   dist33700(:,25) dist33800(:,2:8)];

dist34000=[dist34000(:,1) dist29500(:,26) dist30100(:,26) dist30200(:,26)...
   dist30500(:,26) dist30600(:,26) dist30800(:,26) dist31200(:,26)...
   dist31300(:,26) dist31400(:,26) dist31500(:,26) dist31600(:,26)...
   dist31800(:,26) dist32100(:,26) dist32300(:,26) dist32400(:,26)...
   dist32500(:,26) dist32700(:,26) dist32900(:,26) dist33000(:,26)...
   dist33200(:,26) dist33300(:,26) dist33500(:,26) dist33600(:,26)...
   dist33700(:,26) dist33800(:,26) dist34000(:,2:7)];

dist34200=[dist34200(:,1) dist29500(:,27) dist30100(:,27) dist30200(:,27)...
   dist30500(:,27) dist30600(:,27) dist30800(:,27) dist31200(:,27)...
   dist31300(:,27) dist31400(:,27) dist31500(:,27) dist31600(:,27)...
   dist31800(:,27) dist32100(:,27) dist32300(:,27) dist32400(:,27)...
   dist32500(:,27) dist32700(:,27) dist32900(:,27) dist33000(:,27)...
   dist33200(:,27) dist33300(:,27) dist33500(:,27) dist33600(:,27)...
   dist33700(:,27) dist33800(:,27) dist34000(:,27) dist34200(:,2:6)];

dist34300=[dist34300(:,1) dist29500(:,28) dist30100(:,28) dist30200(:,28)...
   dist30500(:,28) dist30600(:,28) dist30800(:,28) dist31200(:,28)...
   dist31300(:,28) dist31400(:,28) dist31500(:,28) dist31600(:,28)...
   dist31800(:,28) dist32100(:,28) dist32300(:,28) dist32400(:,28)...
```

```
    dist32500(:,28) dist32700(:,28) dist32900(:,28) dist33000(:,28)...
    dist33200(:,28) dist33300(:,28) dist33500(:,28) dist33600(:,28)...
    dist33700(:,28) dist33800(:,28) dist34000(:,28) dist34200(:,28)...
    dist34300(:,2:5)];

dist34600=[dist34600(:,1) dist29500(:,29) dist30100(:,29) dist30200(:,29)...
    dist30500(:,29) dist30600(:,29) dist30800(:,29) dist31200(:,29)...
    dist31300(:,29) dist31400(:,29) dist31500(:,29) dist31600(:,29)...
    dist31800(:,29) dist32100(:,29) dist32300(:,29) dist32400(:,29)...
    dist32500(:,29) dist32700(:,29) dist32900(:,29) dist33000(:,29)...
    dist33200(:,29) dist33300(:,29) dist33500(:,29) dist33600(:,29)...
    dist33700(:,29) dist33800(:,29) dist34000(:,29) dist34200(:,29)...
    dist34300(:,29) dist34600(:,2:4)];

dist34800=[dist34800(:,1) dist29500(:,30) dist30100(:,30) dist30200(:,30)...
    dist30500(:,30) dist30600(:,30) dist30800(:,30) dist31200(:,30)...
    dist31300(:,30) dist31400(:,30) dist31500(:,30) dist31600(:,30)...
    dist31800(:,30) dist32100(:,30) dist32300(:,30) dist32400(:,30)...
    dist32500(:,30) dist32700(:,30) dist32900(:,30) dist33000(:,30)...
    dist33200(:,30) dist33300(:,30) dist33500(:,30) dist33600(:,30)...
    dist33700(:,30) dist33800(:,30) dist34000(:,30) dist34200(:,30)...
    dist34300(:,30) dist34600(:,30) dist34800(:,2:3)];

dist34900=[dist34900(:,1) dist29500(:,31) dist30100(:,31) dist30200(:,31)...
    dist30500(:,31) dist30600(:,31) dist30800(:,31) dist31200(:,31)...
    dist31300(:,31) dist31400(:,31) dist31500(:,31) dist31600(:,31)...
    dist31800(:,31) dist32100(:,31) dist32300(:,31) dist32400(:,31)...
    dist32500(:,31) dist32700(:,31) dist32900(:,31) dist33000(:,31)...
    dist33200(:,31) dist33300(:,31) dist33500(:,31) dist33600(:,31)...
    dist33700(:,31) dist33800(:,31) dist34000(:,31) dist34200(:,31)...
    dist34300(:,31) dist34600(:,31) dist34800(:,31) dist34900(:,2)];

dist35000=[dist34900(:,1) dist29500(:,32) dist30100(:,32) dist30200(:,32)...
    dist30500(:,32) dist30600(:,32) dist30800(:,32) dist31200(:,32)...
    dist31300(:,32) dist31400(:,32) dist31500(:,32) dist31600(:,32)...
    dist31800(:,32) dist32100(:,32) dist32300(:,32) dist32400(:,32)...
    dist32500(:,32) dist32700(:,32) dist32900(:,32) dist33000(:,32)...
    dist33200(:,32) dist33300(:,32) dist33500(:,32) dist33600(:,32)...
    dist33700(:,32) dist33800(:,32) dist34000(:,32) dist34200(:,32)...
    dist34300(:,32) dist34600(:,32) dist34800(:,32) dist34900(:,2)];
```

filter3d.m

```
%create a new variable 'newfilter' by assigning combined 2d data to it
%the variable will have 8 columns- tag id, seconds, x, y, pressure,
%reliability #, condition #, and GDOP

newfilter=data;

k=find(newfilter(:,6)<=3); %filter by reliability # (deg of freedom)
newfilter=newfilter(k,:);  %assign only filtered values to newfilter

k=find(newfilter(:,7)<15); %filter by condition #
newfilter=newfilter(k,:);

k=find(newfilter(:,8)<3); %filter by GDOP (precision estimate)
newfilter=newfilter(k,:);

clear k
```

interpbr.m

```
% interpbr
% Program to interpolate blue runner fish positions on to a regular time
% base while maintaining NaN locations to preserve gaps in data.
% Example input data consists of three columns: time(yearday), x(m), y(m),
% Gaps greater than 60s are separated with NaNs in each column

% load the datafile (.mat) to be processed
uiload
pause(10);
a=whos; % read variable name into temporary variable 'a'
eval(['br=' a.name ';']); % rename variable 'br'
eval(['clear ans a ' a.name]); % clear unnecessary variables

% Find all the NaN locations
a=isnan(br(:,1));
b=find(a==1); % contains index into NaN rows
clear a;

% Convert elapsed time in seconds to year-day
yyyy=input('Enter the year (yyyy) >');
mm=input('Enter the month (mm) >');
dd=input('Enter the day (dd) >');

br(:,1)=br(:,1)/(24*60*60)+(datenum(yyyy,mm,dd)-datenum(yyyy-1,12,31));
tmp2=[];
tmp=[br(1:b(1)-1,:)];
if length(tmp(:,1))>1,
   time=[tmp(1,1):5/(24*60*60):tmp(end,1)]'; % 5 s intervals
   tmp2=interp1(tmp(:,1),tmp(:,2:3),time);
   tmp2=[time tmp2];
end;
tmp=[tmp2;NaN NaN NaN];
clear tmp2; % tmp now holds the first section of the data interpolated on to a
         % 5s time base.
for a=1:length(b)-1,
   tmp2=[br(b(a)+1:b(a+1)-1,:)];
   if length(tmp2(:,1))>1,
      time=[tmp2(1,1):5/(24*60*60):tmp2(end,1)]'; % 5 s intervals
      tmp3=interp1(tmp2(:,1),tmp2(:,2:3),time);
      tmp3=[time tmp3];
      tmp=[tmp;tmp3;NaN NaN NaN];
      clear tmp3;
   else
      tmp=[tmp;tmp2;NaN NaN NaN];
      clear tmp2;
   end;
end;
% Now process the remainder of the file after the last NaN;
```

```
if b(end)<length(br(:,1)),
   tmp2=[br(b(end)+1:end,:)];
   if length(tmp2(:,1))>1,
      time=[tmp2(1,1):5/(24*60*60):tmp2(end,1)]'; % 5 s intervals
      tmp3=interp1(tmp2(:,1),tmp2(:,2:3),time);
      tmp3=[time tmp3];
      tmp=[tmp;tmp3;NaN NaN NaN];
      clear tmp3;
   else
      tmp=[tmp;tmp2];
   end;
end;
clear a b tmp2;
% At this point, the file tmp contains time and corresponding x,y coordinates of
% the fish at 5s intervals.

% Next add the depth data to the file.

uiload % open dialog box to load the datafile containing time (sec) and depth
pause(10)
a=whos; % read variable name into temporary variable 'a'
c=getfield(a(2),'name');
eval(['depth=' c ';']); % rename variable 'br'
eval(['clear ans a ' c ' c']); % clear unnecessary variables

% Interpolate depth on to a 1 s time base;
depth(:,1)=depth(:,1)/(24*60*60)+(datenum(yyyy,mm,dd)-datenum(yyyy-1,12,31));
% check for and eliminate duplicate times.
k=find((depth(2:end,1)-depth(1:end-1,1))==0);
depth(k,:)=[];

time1s=[depth(1,1):1/(24*60*60):depth(end,1)]';
depth1s=interp1(depth(:,1),depth(:,2),time1s);
depth1s=[time1s depth1s];

% At this point depth1s is an nx2 matrix with time(yd) and depth at 1s
% intervals.

if isnan(tmp(1,1))%Check to see if the first line of tmp is NaN
   tmp(1,:)=[]; %eliminate first row if it contains NaNs
end

if isnan(tmp(end,1))%Check to see that tmp does not end in a NaN
   tmp(end,:)=[]; %eliminate last row if it contains NaNs
end
% Now work through the position data (tmp) to match up sections of the
% depth data. Depth data will be reinterpolated to match with the time.
% First match up the section of the depth data that corresponds to the
% start and end of the position data.
k=find(depth1s(:,1)>=tmp(1,1) & depth1s(:,1)<=tmp(end,1));
```

```
depth1s=depth1s(k,:);


%if isempty(k)==0,
   tmp2=interp1(depth1s(:,1),depth1s(:,2),tmp(:,1));
   tmp=[tmp tmp2];
%else
  % tmpp=size(tmp);
   %tmp=[tmp ones(tmpp(1),1)*NaN];
%end;
clear k

z=1;

while z < 3
   if isnan(tmp(1,4))
    tmp(1,:)=[];
      z=z+1;
   else
      z=3;
   end
end

while z==3
   if isnan(tmp2(end))
      tmp2(end,:)=[];
      tmp(end,:)=[];
   else
      z=4;
   end
end

% tmp now holds time, x, y, z

% Smooth the data with a 5 point running mean filter
% Use only the sections between NaNs
a=isnan(tmp(:,1));
b=find(a==1); % b is now an array with NaN locations
if b>=1
   section1=tmp(1:b(1)-1,:);
else
   section1=tmp;
end
clear a;

% Process the section of data preceding the first NaN
if length(section1(:,1))>=5,
   for a=3:length(section1(:,1))-2,
      smooth_br_5s(a,1)=section1(a,1);
      smooth_br_5s(a,2:4)=mean(section1(a-2:a+2,2:4));
```

```
    end;
    smooth_br_5s(1:2,1)=section1(1:2,1);
    smooth_br_5s(1,2:4)=mean(section1(1:2,2:4));
    smooth_br_5s(2,2:4)=mean(section1(2:3,2:4));
    smooth_br_5s(end,2:4)=mean(section1(end-1:end,2:4));
elseif length(section1(:,1))==4,
    smooth_br_5s(1,2:4)=mean(section1(1:2,2:4));
    smooth_br_5s(2,2:4)=mean(section1(1:3,2:4));
    smooth_br_5s(3,2:4)=mean(section1(2:4,2:4));
    smooth_br_5s(4,2:4)=mean(section1(3:4,2:4));
elseif length(section1(:,1))==3,
    smooth_br_5s(1:3,1)=section1(1:3,1);
    smooth_br_5s(1,2:4)=mean(section1(1:2,2:4));
    smooth_br_5s(2,2:4)=mean(section1(1:3,2:4));
    smooth_br_5s(3,2:4)=mean(section1(2:3,2:4));
elseif length(section1(:,1))<=2,
    smooth_br_5s=[section1;NaN NaN NaN NaN];
end;

% smooth_br_5s now contains the smoothed first section of data
for a=1:length(b)-1,
    section2=tmp(b(a)+1:b(a+1)-1,:);
    if length(section2(:,1))>=5,
        for a=3:length(section2(:,1))-2,
            temp_smooth_5s(a,1)=section2(a,1);
            temp_smooth_5s(a,2:4)=mean(section2(a-2:a+2,2:4));
        end;
        temp_smooth_5s(1,2:4)=mean(section2(1:2,2:4));
        temp_smooth_5s(2,2:4)=mean(section2(2:3,2:4));
        temp_smooth_5s(end,2:4)=mean(section2(end-1:end,2:4));
    elseif length(section2(:,1))==4,
        temp_smooth_5s(1,2:4)=mean(section2(1:2,2:4));
        temp_smooth_5s(2,2:4)=mean(section2(1:3,2:4));
        temp_smooth_5s(3,2:4)=mean(section2(2:4,2:4));
        temp_smooth_5s(4,2:4)=mean(section2(3:4,2:4));
    elseif length(section2(:,1))==3,
        temp_smooth_5s(1,2:4)=mean(section2(1:2,2:4));
        temp_smooth_5s(2,2:4)=mean(section2(1:3,2:4));
        temp_smooth_5s(3,2:4)=mean(section2(2:3,2:4));
    elseif length(section2(:,1))<=2,
        temp_smooth_5s=section2;
    end;
    smooth_br_5s=[smooth_br_5s;section2;NaN NaN NaN NaN];
    clear section2 temp_smooth_5s
end;
% Finally, process the section after the last NaN
if b>=1
section1=tmp(b(end)+1:end,:);
end
clear a;
```

```
if length(section1(:,1))>=5,
   for a=3:length(section1(:,1))-2,
      temp_smooth_5s(1:2,1)=section1(1:2,1);
      temp_smooth_5s(a,1)=section1(a,1);
      temp_smooth_5s(a,2:4)=mean(section1(a-2:a+2,2:4));
   end;
   temp_smooth_5s(1,2:4)=section1(1,2:4);
   temp_smooth_5s(2,2:4)=mean(section1(1:2,2:4));
   temp_smooth_5s(end,2:4)=mean(section1(end-1:end,2:4));
elseif length(section1(:,1))==4,
   temp_smooth_5s(1,2:4)=mean(section1(1:2,2:4));
   temp_smooth_5s(2,2:4)=mean(section1(1:3,2:4));
   temp_smooth_5s(3,2:4)=mean(section1(2:4,2:4));
   temp_smooth_5s(4,2:4)=mean(section1(3:4,2:4));
elseif length(section1(:,1))==3,
   temp_smooth_5s(1,2:4)=mean(section1(1:2,2:4));
   temp_smooth_5s(2,2:4)=mean(section1(1:3,2:4));
   temp_smooth_5s(3,2:4)=mean(section1(2:3,2:4));
elseif length(section1(:,1))<=2,
   temp_smooth_5s=[section1;NaN NaN NaN NaN];
end;
smooth_br_5s=[smooth_br_5s;temp_smooth_5s];
% smooth_br_5s now contains the smoothed data estimates at 5 s intervals.


clear a b* d* mm section1 t* yyyy z
```

night05.m

```
%night05.m finds all the data found between sundown and sunrise during the
%2005 research
%Put data into a temp file called data which has four columns - TagId,
%yearday, depth and power

k=find(data(:,2)>216.784028); %finds data after sunset on 4Aug05
temp=data(k,:); %assigns all data to a temp variable
k=find(temp(:,2)<217.225694); %finds data before sunrise on 5Aug05
night=temp(k,:); %assigns nighttime data to new variable

k=find(data(:,2)>217.784028); %finds data after sunset on 5Aug05
temp=data(k,:);
k=find(temp(:,2)<218.225694); %finds data before sunrise on 6Aug05
temp=temp(k,:); %filters out only the nightime data
night=[night;temp]; %appends the second night's data to the first night's

k=find(data(:,2)>218.783333);
temp=data(k,:);
k=find(temp(:,2)<219.226389);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>219.782369);
temp=data(k,:);
k=find(temp(:,2)<220.227083);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>220.78194);
temp=data(k,:);
k=find(temp(:,2)<221.227083);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>221.781250);
temp=data(k,:);
k=find(temp(:,2)<222.227778);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>222.781250);
temp=data(k,:);
k=find(temp(:,2)<223.227778);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>223.780556);
temp=data(k,:);
```

```
k=find(temp(:,2)<224.228472);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>224.779861);
temp=data(k,:);
k=find(temp(:,2)<225.228472);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>225.779167);
temp=data(k,:);
k=find(temp(:,2)<226.229167);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>226.778472);
temp=data(k,:);
k=find(temp(:,2)<227.229167);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>227.777778);
temp=data(k,:);
k=find(temp(:,2)<228.229861);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>228.777083);
temp=data(k,:);
k=find(temp(:,2)<229.229861);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>229.776389);
temp=data(k,:);
k=find(temp(:,2)<230.230556);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>230.775694);
temp=data(k,:);
k=find(temp(:,2)<231.231250);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>231.775000);
temp=data(k,:);
k=find(temp(:,2)<232.231250);
temp=temp(k,:);
```

```
night=[night;temp];

k=find(data(:,2)>232.774306);
temp=data(k,:);
k=find(temp(:,2)<233.231944);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>233.773611);
temp=data(k,:);
k=find(temp(:,2)<234.231944);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>234.772917);
temp=data(k,:);
k=find(temp(:,2)<235.232639);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>235.772222);
temp=data(k,:);
k=find(temp(:,2)<236.232639);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>236.771528);
temp=data(k,:);
k=find(temp(:,2)<237.233333);
temp=temp(k,:);
night=[night;temp];

k=find(data(:,2)>237.770833);
temp=data(k,:);
k=find(temp(:,2)<238.233333);
temp=temp(k,:);
night=[night;temp];
clear k temp data
```

nightdist.m

```
%This routine determines the euclidean distance of fish from
%the center of the six platforms at ST151 complex in August 2005 at night.
%The night data variables
%have 5 columns - defined as follows:
%   1 - fish id
%   2 - yearday
%   3 - x coordinate
%   4 - y coordinate
%   5 - z coordinate
%The centers of the platforms were determined using ArcGIS 9.2 Mean Center
%tool.  The data represent x and y coordinates of the calculated center of
%the platforms.
%calculate the distance between fish and the center of
%Old Quarters platform
x1=night(:,3);
y1=night(:,4);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQdist=[night(:,2) dist];

%calculate the distance between fish and the center of
%Production 1 platform
x1=night(:,3);
y1=night(:,4);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1dist=[night(:,2) dist];

%calculate the distance between fish and the center of
%Production 2 platform
x1=night(:,3);
y1=night(:,4);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));
```

```
P2dist=[night(:,2) dist];

%calculate the distance between fish and the center of
%Compressor platform
x1=night(:,3);
y1=night(:,4);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compdist=[night(:,2) dist];

%calculate the distance between fish and the center of
%G-Deck platform
x1=night(:,3);
y1=night(:,4);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gdist=[night(:,2) dist];

%calculate the distance between fish and the center of
%Yankee platform
x1=night(:,3);
y1=night(:,4);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Ydist=[night(:,2) dist];
clear dist x* y y1 y2
```

nightspeed.m

```
j=1;

ntime=(night(2:end,1)-night(1:end-1,1))*86400;

while j<length(night)
   x1=night(j,2);
   y1=night(j,3);
   z1=night(j,4);

   x2=night(j+1,2);
   y2=night(j+1,3);
   z2=night(j+1,4);

   x=x2-x1;
   y=y2-y1;
   z=z2-z1;

   ndist(j,1)=sqrt((x.^2)+(y.^2)+(z.^2));
   j=j+1;
end

r=1;
while r<=length(ntime)
   nspeed(r,1)=ndist(r,1)/ntime(r,1);
   r=r+1;
end

nbodylengths=nspeed/forklength;

clear x* y* z* j r
```

nightstats.m

```
%This routine calculates the mean and variance of the depth distribution of
%the fish on a given day and saves them as individual variables.

k=find(night(:,2)<217);
temp=night(k,:);
l=length(temp);
if l>1
   mean0804=mean(temp(:,3));
   var0804=var(temp(:,3));
else
   mean0804=NaN;
   var0804=NaN;
end
night(k,:)=[];

k=find(night(:,2)<218);
temp=night(k,:);
l=length(temp);
if l>1
   mean0805=mean(temp(:,3));
   var0805=var(temp(:,3));
else
   mean0805=NaN;
   var0805=NaN;
end
night(k,:)=[];

k=find(night(:,2)<219);
temp=night(k,:);
l=length(temp);
if l>1
   mean0806=mean(temp(:,3));
   var0806=var(temp(:,3));
else
   mean0806=NaN;
   var0806=NaN;
end
night(k,:)=[];

k=find(night(:,2)<220);
temp=night(k,:);
l=length(temp);
if l>1
   mean0807=mean(temp(:,3));
   var0807=var(temp(:,3));
else
   mean0807=NaN;
   var0807=NaN;
```

```
end
night(k,:)=[];

k=find(night(:,2)<221);
temp=night(k,:);
l=length(temp);
if l>1
   mean0808=mean(temp(:,3));
   var0808=var(temp(:,3));
else
   mean0808=NaN;
   var0808=NaN;
end
night(k,:)=[];

k=find(night(:,2)<222);
temp=night(k,:);
l=length(temp);
if l>1
   mean0809=mean(temp(:,3));
   var0809=var(temp(:,3));
else
   mean0809=NaN;
   var0809=NaN;
end
night(k,:)=[];

k=find(night(:,2)<223);
temp=night(k,:);
l=length(temp);
if l>1
   mean0810=mean(temp(:,3));
   var0810=var(temp(:,3));
else
   mean0810=NaN;
   var0810=NaN;
end
night(k,:)=[];

k=find(night(:,2)<224);
temp=night(k,:);
l=length(temp);
if l>1
   mean0811=mean(temp(:,3));
   var0811=var(temp(:,3));
else
   mean0811=NaN;
   var0811=NaN;
end
night(k,:)=[];
```

```
k=find(night(:,2)<225);
temp=night(k,:);
l=length(temp);
if l>1
   mean0812=mean(temp(:,3));
   var0812=var(temp(:,3));
else
   mean0812=NaN;
   var0812=NaN;
end
night(k,:)=[];

k=find(night(:,2)<226);
temp=night(k,:);
l=length(temp);
if l>1
   mean0813=mean(temp(:,3));
   var0813=var(temp(:,3));
else
   mean0813=NaN;
   var0813=NaN;
end
night(k,:)=[];

k=find(night(:,2)<227);
temp=night(k,:);
l=length(temp);
if l>1
   mean0814=mean(temp(:,3));
   var0814=var(temp(:,3));
else
   mean0814=NaN;
   var0814=NaN;
end
night(k,:)=[];

k=find(night(:,2)<228);
temp=night(k,:);
l=length(temp);
if l>1
   mean0815=mean(temp(:,3));
   var0815=var(temp(:,3));
else
   mean0815=NaN;
   var0815=NaN;
end
night(k,:)=[];

k=find(night(:,2)<229);
```

```
temp=night(k,:);
l=length(temp);
if l>1
   mean0816=mean(temp(:,3));
   var0816=var(temp(:,3));
else
   mean0816=NaN;
   var0816=NaN;
end
night(k,:)=[];

k=find(night(:,2)<230);
temp=night(k,:);
l=length(temp);
if l>1
   mean0817=mean(temp(:,3));
   var0817=var(temp(:,3));
else
   mean0817=NaN;
   var0817=NaN;
end
night(k,:)=[];

k=find(night(:,2)<231);
temp=night(k,:);
l=length(temp);
if l>1
   mean0818=mean(temp(:,3));
   var0818=var(temp(:,3));
else
   mean0818=NaN;
   var0818=NaN;
end
night(k,:)=[];

k=find(night(:,2)<232);
temp=night(k,:);
l=length(temp);
if l>1
   mean0819=mean(temp(:,3));
   var0819=var(temp(:,3));
else
   mean0819=NaN;
   var0819=NaN;
end
night(k,:)=[];

k=find(night(:,2)<233);
temp=night(k,:);
l=length(temp);
```

```
if l>1
   mean0820=mean(temp(:,3));
   var0820=var(temp(:,3));
else
   mean0820=NaN;
   var0820=NaN;
end
night(k,:)=[];

k=find(night(:,2)<234);
temp=night(k,:);
l=length(temp);
if l>1
   mean0821=mean(temp(:,3));
   var0821=var(temp(:,3));
else
   mean0821=NaN;
   var0821=NaN;
end
night(k,:)=[];

k=find(night(:,2)<235);
temp=night(k,:);
l=length(temp);
if l>1
   mean0822=mean(temp(:,3));
   var0822=var(temp(:,3));
else
   mean0822=NaN;
   var0822=NaN;
end
night(k,:)=[];

k=find(night(:,2)<236);
temp=night(k,:);
l=length(temp);
if l>1
   mean0823=mean(temp(:,3));
   var0823=var(temp(:,3));
else
   mean0823=NaN;
   var0823=NaN;
end
night(k,:)=[];

k=find(night(:,2)<237);
temp=night(k,:);
l=length(temp);
if l>1
   mean0824=mean(temp(:,3));
```

```
    var0824=var(temp(:,3));
else
    mean0824=NaN;
    var0824=NaN;
end
night(k,:)=[];

k=find(night(:,2)<238);
temp=night(k,:);
l=length(temp);
if l>1
    mean0825=mean(temp(:,3));
    var0825=var(temp(:,3));
else
    mean0825=NaN;
    var0825=NaN;
end
night(k,:)=[];

k=find(night(:,2)<239);
temp=night(k,:);
l=length(temp);
if l>1
    mean0826=mean(temp(:,3));
    var0826=var(temp(:,3));
else
    mean0826=NaN;
    var0826=NaN;
end
night(k,:)=[];

clear k l temp night
```

platdist.m

```
%This routine determines the euclidean distance of schooling points from
%the center of the six platforms at ST151 complex in August 2005.
%Separates the data into day and night variables and runs t-tests
%to determine if there is a statistical difference between the locations
%of the schools during different time periods.The daily data variables
%have 8 columns - defined as follows:
%   1 - time of day in seconds (0-86400) on a five second grid
%   2 - x coordinate of Fish 1
%   3 - y coordinate of Fish 1
%   4 - z coordinate of Fish 1
%   5 - x coordinate of Fish 2
%   6 - y coordinate of Fish 2
%   7 - z coordinate of Fish 2
%   8 - euclidean distance between the two fish in meters
%The centers of the platforms were determined using ArcGIS 9.2 Mean Center
%tool.  The data represent x and y coordinates of the calculated center of
%the platforms.

%Calculate the center point between the two fish in a school.  The z coord.
%will not be used because only a 2d position for the center of the
%platforms are known.
x1=aug06school(:,2);
y1=aug06school(:,3);
x2=aug06school(:,5);
y2=aug06school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

%Put the central point of the schooling location data into a variable
%with time (seconds ), x and y.
aug06points=[aug06school(:,1) x y];

clear x* y y1 y2

x1=aug07school(:,2);
y1=aug07school(:,3);
x2=aug07school(:,5);
y2=aug07school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug07points=[aug07school(:,1) x y];

clear x* y y1 y2

x1=aug08school(:,2);
```

```
y1=aug08school(:,3);
x2=aug08school(:,5);
y2=aug08school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

%Put the central point of the schooling location data into a variable
%with time (seconds ), x and y.
aug08points=[aug08school(:,1) x y];

clear x* y y1 y2

%Repeat for all days
x1=aug09school(:,2);
y1=aug09school(:,3);
x2=aug09school(:,5);
y2=aug09school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug09points=[aug09school(:,1) x y];

clear x* y y1 y2

x1=aug10school(:,2);
y1=aug10school(:,3);
x2=aug10school(:,5);
y2=aug10school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug10points=[aug10school(:,1) x y];

clear x* y y1 y2

x1=aug11school(:,2);
y1=aug11school(:,3);
x2=aug11school(:,5);
y2=aug11school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug11points=[aug11school(:,1) x y];

clear x* y y1 y2
```

```
x1=aug12school(:,2);
y1=aug12school(:,3);
x2=aug12school(:,5);
y2=aug12school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug12points=[aug12school(:,1) x y];

clear x* y y1 y2

x1=aug13school(:,2);
y1=aug13school(:,3);
x2=aug13school(:,5);
y2=aug13school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug13points=[aug13school(:,1) x y];

clear x* y y1 y2

x1=aug14school(:,2);
y1=aug14school(:,3);
x2=aug14school(:,5);
y2=aug14school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug14points=[aug14school(:,1) x y];

clear x* y y1 y2

x1=aug15school(:,2);
y1=aug15school(:,3);
x2=aug15school(:,5);
y2=aug15school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug15points=[aug15school(:,1) x y];

clear x* y y1 y2

x1=aug16school(:,2);
y1=aug16school(:,3);
```

```
x2=aug16school(:,5);
y2=aug16school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug16points=[aug16school(:,1) x y];

clear x* y y1 y2

x1=aug17school(:,2);
y1=aug17school(:,3);
x2=aug17school(:,5);
y2=aug17school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug17points=[aug17school(:,1) x y];

clear x* y y1 y2

x1=aug18school(:,2);
y1=aug18school(:,3);
x2=aug18school(:,5);
y2=aug18school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug18points=[aug18school(:,1) x y];

clear x* y y1 y2

x1=aug19school(:,2);
y1=aug19school(:,3);
x2=aug19school(:,5);
y2=aug19school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug19points=[aug19school(:,1) x y];

clear x* y y1 y2

x1=aug20school(:,2);
y1=aug20school(:,3);
x2=aug20school(:,5);
y2=aug20school(:,6);
```

```
x=(x1+x2)/2;
y=(y1+y2)/2;

aug20points=[aug20school(:,1) x y];

clear x* y y1 y2

x1=aug21school(:,2);
y1=aug21school(:,3);
x2=aug21school(:,5);
y2=aug21school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug21points=[aug21school(:,1) x y];

clear x* y y1 y2

x1=aug22school(:,2);
y1=aug22school(:,3);
x2=aug22school(:,5);
y2=aug22school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug22points=[aug22school(:,1) x y];

clear x* y y1 y2

x1=aug23school(:,2);
y1=aug23school(:,3);
x2=aug23school(:,5);
y2=aug23school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug23points=[aug23school(:,1) x y];

clear x* y y1 y2

x1=aug24school(:,2);
y1=aug24school(:,3);
x2=aug24school(:,5);
y2=aug24school(:,6);

x=(x1+x2)/2;
```

```
y=(y1+y2)/2;

aug24points=[aug24school(:,1) x y];

clear x* y y1 y2

x1=aug25school(:,2);
y1=aug25school(:,3);
x2=aug25school(:,5);
y2=aug25school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug25points=[aug25school(:,1) x y];

clear x* y y1 y2

x1=aug26school(:,2);
y1=aug26school(:,3);
x2=aug26school(:,5);
y2=aug26school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug26points=[aug26school(:,1) x y];

clear x* y y1 y2

x1=aug27school(:,2);
y1=aug27school(:,3);
x2=aug27school(:,5);
y2=aug27school(:,6);

x=(x1+x2)/2;
y=(y1+y2)/2;

aug27points=[aug27school(:,1) x y];

clear x* y y1 y2

load platformcenter %load the platform center coordinates

%calculate the distance between schooling points and the center of
%Old Quarters platform
x1=aug06points(:,2);
y1=aug06points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);
```

```
x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist06=[aug06points(:,1) dist];

clear x* y y1 y2 dist

x1=aug07points(:,2);
y1=aug07points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist07=[aug07points(:,1) dist];

clear x* y y1 y2 dist

x1=aug08points(:,2);
y1=aug08points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist08=[aug08points(:,1) dist];

clear x* y y1 y2 dist

x1=aug09points(:,2);
y1=aug09points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist09=[aug09points(:,1) dist];

clear x* y y1 y2 dist
x1=aug10points(:,2);
y1=aug10points(:,3);
x2=OQCenter(:,1);
```

```
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist10=[aug10points(:,1) dist];

clear x* y y1 y2 dist

x1=aug11points(:,2);
y1=aug11points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist11=[aug11points(:,1) dist];

clear x* y y1 y2 dist

x1=aug12points(:,2);
y1=aug12points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist12=[aug12points(:,1) dist];

clear x* y y1 y2 dist

x1=aug13points(:,2);
y1=aug13points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist13=[aug13points(:,1) dist];

clear x* y y1 y2 dist

x1=aug14points(:,2);
```

```
y1=aug14points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist14=[aug14points(:,1) dist];

clear x* y y1 y2 dist

x1=aug15points(:,2);
y1=aug15points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist15=[aug15points(:,1) dist];

clear x* y y1 y2 dist

x1=aug16points(:,2);
y1=aug16points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist16=[aug16points(:,1) dist];

clear x* y y1 y2 dist

x1=aug17points(:,2);
y1=aug17points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist17=[aug17points(:,1) dist];

clear x* y y1 y2 dist
```

```
x1=aug18points(:,2);
y1=aug18points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist18=[aug18points(:,1) dist];

clear x* y y1 y2 dist

x1=aug19points(:,2);
y1=aug19points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist19=[aug19points(:,1) dist];

clear x* y y1 y2 dist

x1=aug20points(:,2);
y1=aug20points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist20=[aug20points(:,1) dist];

clear x* y y1 y2 dist

x1=aug21points(:,2);
y1=aug21points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist21=[aug21points(:,1) dist];
```

```
clear x* y y1 y2 dist

x1=aug22points(:,2);
y1=aug22points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist22=[aug22points(:,1) dist];

clear x* y y1 y2 dist

x1=aug23points(:,2);
y1=aug23points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist23=[aug23points(:,1) dist];

clear x* y y1 y2 dist

x1=aug24points(:,2);
y1=aug24points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist24=[aug24points(:,1) dist];

clear x* y y1 y2 dist

x1=aug25points(:,2);
y1=aug25points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));
```

```
OQschooldist25=[aug25points(:,1) dist];

clear x* y y1 y2 dist

x1=aug26points(:,2);
y1=aug26points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist26=[aug26points(:,1) dist];

clear x* y y1 y2 dist

x1=aug27points(:,2);
y1=aug27points(:,3);
x2=OQCenter(:,1);
y2=OQCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

OQschooldist27=[aug27points(:,1) dist];

OQschooldist=[OQschooldist06;OQschooldist07;OQschooldist08;...
   OQschooldist09;OQschooldist10;OQschooldist11;OQschooldist12;...
   OQschooldist13;OQschooldist14;OQschooldist15;OQschooldist16;...
   OQschooldist17;OQschooldist18;OQschooldist19;OQschooldist20;...
   OQschooldist21;OQschooldist22;OQschooldist23;OQschooldist24;...
   OQschooldist25;OQschooldist26;OQschooldist27];

clear x* y y1 y2 dist

%calculate the distance between schooling points and the center of
%Production 1 platform
x1=aug06points(:,2);
y1=aug06points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist06=[aug06points(:,1) dist];
```

```
clear x* y y1 y2 dist

x1=aug07points(:,2);
y1=aug07points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist07=[aug07points(:,1) dist];

clear x* y y1 y2 dist

x1=aug08points(:,2);
y1=aug08points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist08=[aug08points(:,1) dist];

clear x* y y1 y2 dist

x1=aug09points(:,2);
y1=aug09points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist09=[aug09points(:,1) dist];

clear x* y y1 y2 dist

x1=aug10points(:,2);
y1=aug10points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));
```

```
P1schooldist10=[aug10points(:,1) dist];

clear x* y y1 y2 dist

x1=aug11points(:,2);
y1=aug11points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist11=[aug11points(:,1) dist];

clear x* y y1 y2 dist

x1=aug12points(:,2);
y1=aug12points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist12=[aug12points(:,1) dist];

clear x* y y1 y2 dist

x1=aug13points(:,2);
y1=aug13points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist13=[aug13points(:,1) dist];

clear x* y y1 y2 dist

x1=aug14points(:,2);
y1=aug14points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
```

```
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist14=[aug14points(:,1) dist];

clear x* y y1 y2 dist

x1=aug15points(:,2);
y1=aug15points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist15=[aug15points(:,1) dist];

clear x* y y1 y2 dist

x1=aug16points(:,2);
y1=aug16points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist16=[aug16points(:,1) dist];

clear x* y y1 y2 dist

x1=aug17points(:,2);
y1=aug17points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist17=[aug17points(:,1) dist];

clear x* y y1 y2 dist

x1=aug18points(:,2);
y1=aug18points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);
```

```
x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist18=[aug18points(:,1) dist];

clear x* y y1 y2 dist

x1=aug19points(:,2);
y1=aug19points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist19=[aug19points(:,1) dist];

clear x* y y1 y2 dist

x1=aug20points(:,2);
y1=aug20points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist20=[aug20points(:,1) dist];

clear x* y y1 y2 dist

x1=aug21points(:,2);
y1=aug21points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist21=[aug21points(:,1) dist];

clear x* y y1 y2 dist

x1=aug22points(:,2);
y1=aug22points(:,3);
```

```
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist22=[aug22points(:,1) dist];

clear x* y y1 y2 dist

x1=aug23points(:,2);
y1=aug23points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist23=[aug23points(:,1) dist];

clear x* y y1 y2 dist

x1=aug24points(:,2);
y1=aug24points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist24=[aug24points(:,1) dist];

clear x* y y1 y2 dist

x1=aug25points(:,2);
y1=aug25points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist25=[aug25points(:,1) dist];

clear x* y y1 y2 dist
```

```
x1=aug26points(:,2);
y1=aug26points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist26=[aug26points(:,1) dist];

clear x* y y1 y2 dist

x1=aug27points(:,2);
y1=aug27points(:,3);
x2=P1Center(:,1);
y2=P1Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P1schooldist27=[aug27points(:,1) dist];

P1schooldist=[P1schooldist06;P1schooldist07;P1schooldist08;...
   P1schooldist09;P1schooldist10;P1schooldist11;...
   P1schooldist12;P1schooldist13;P1schooldist14;P1schooldist15;...
   P1schooldist16;P1schooldist17;P1schooldist18;P1schooldist19;...
   P1schooldist20;P1schooldist21;P1schooldist22;P1schooldist23;...
   P1schooldist24;P1schooldist25;P1schooldist26;P1schooldist27];

clear x* y y1 y2 dist

%calculate the distance between schooling points and the center of
%Production 2 platform
x1=aug06points(:,2);
y1=aug06points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist06=[aug06points(:,1) dist];

clear x* y y1 y2 dist

x1=aug07points(:,2);
y1=aug07points(:,3);
```

```
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist07=[aug07points(:,1) dist];

clear x* y y1 y2 dist

x1=aug08points(:,2);
y1=aug08points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist08=[aug08points(:,1) dist];

clear x* y y1 y2 dist

x1=aug09points(:,2);
y1=aug09points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist09=[aug09points(:,1) dist];

clear x* y y1 y2 dist
x1=aug10points(:,2);
y1=aug10points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist10=[aug10points(:,1) dist];

clear x* y y1 y2 dist

x1=aug11points(:,2);
```

```
y1=aug11points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist11=[aug11points(:,1) dist];

clear x* y y1 y2 dist

x1=aug12points(:,2);
y1=aug12points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist12=[aug12points(:,1) dist];

clear x* y y1 y2 dist

x1=aug13points(:,2);
y1=aug13points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist13=[aug13points(:,1) dist];

clear x* y y1 y2 dist

x1=aug14points(:,2);
y1=aug14points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist14=[aug14points(:,1) dist];

clear x* y y1 y2 dist
```

```
x1=aug15points(:,2);
y1=aug15points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist15=[aug15points(:,1) dist];

clear x* y y1 y2 dist

x1=aug16points(:,2);
y1=aug16points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist16=[aug16points(:,1) dist];

clear x* y y1 y2 dist

x1=aug17points(:,2);
y1=aug17points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist17=[aug17points(:,1) dist];

clear x* y y1 y2 dist

x1=aug18points(:,2);
y1=aug18points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist18=[aug18points(:,1) dist];
```

```
clear x* y y1 y2 dist

x1=aug19points(:,2);
y1=aug19points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist19=[aug19points(:,1) dist];

clear x* y y1 y2 dist

x1=aug20points(:,2);
y1=aug20points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist20=[aug20points(:,1) dist];

clear x* y y1 y2 dist

x1=aug21points(:,2);
y1=aug21points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist21=[aug21points(:,1) dist];

clear x* y y1 y2 dist

x1=aug22points(:,2);
y1=aug22points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));
```

```
P2schooldist22=[aug22points(:,1) dist];

clear x* y y1 y2 dist

x1=aug23points(:,2);
y1=aug23points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist23=[aug23points(:,1) dist];

clear x* y y1 y2 dist

x1=aug24points(:,2);
y1=aug24points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist24=[aug24points(:,1) dist];

clear x* y y1 y2 dist

x1=aug25points(:,2);
y1=aug25points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist25=[aug25points(:,1) dist];

clear x* y y1 y2 dist

x1=aug26points(:,2);
y1=aug26points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
```

```
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist26=[aug26points(:,1) dist];

clear x* y y1 y2 dist

x1=aug27points(:,2);
y1=aug27points(:,3);
x2=P2Center(:,1);
y2=P2Center(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

P2schooldist27=[aug27points(:,1) dist];

P2schooldist=[P2schooldist06;P2schooldist06;P2schooldist08;...
   P2schooldist09;P2schooldist10;P2schooldist11;...
   P2schooldist12;P2schooldist13;P2schooldist14;P2schooldist15;...
   P2schooldist16;P2schooldist17;P2schooldist18;P2schooldist19;...
   P2schooldist20;P2schooldist21;P2schooldist22;P2schooldist23;...
   P2schooldist24;P2schooldist25;P2schooldist26;P2schooldist27];

clear x* y y1 y2 dist

%calculate the distance between schooling points and the center of
%Compressor platform
x1=aug06points(:,2);
y1=aug06points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist06=[aug06points(:,1) dist];

clear x* y y1 y2 dist

x1=aug07points(:,2);
y1=aug07points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));
```

```
Compschooldist07=[aug07points(:,1) dist];

clear x* y y1 y2 dist

x1=aug08points(:,2);
y1=aug08points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist08=[aug08points(:,1) dist];

clear x* y y1 y2 dist

x1=aug09points(:,2);
y1=aug09points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist09=[aug09points(:,1) dist];

clear x* y y1 y2 dist

x1=aug10points(:,2);
y1=aug10points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist10=[aug10points(:,1) dist];

clear x* y y1 y2 dist

x1=aug11points(:,2);
y1=aug11points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
```

```
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist11=[aug11points(:,1) dist];

clear x* y y1 y2 dist

x1=aug12points(:,2);
y1=aug12points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist12=[aug12points(:,1) dist];

clear x* y y1 y2 dist

x1=aug13points(:,2);
y1=aug13points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist13=[aug13points(:,1) dist];

clear x* y y1 y2 dist

x1=aug14points(:,2);
y1=aug14points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist14=[aug14points(:,1) dist];

clear x* y y1 y2 dist

x1=aug15points(:,2);
y1=aug15points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);
```

```
x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist15=[aug15points(:,1) dist];

clear x* y y1 y2 dist

x1=aug16points(:,2);
y1=aug16points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist16=[aug16points(:,1) dist];

clear x* y y1 y2 dist

x1=aug17points(:,2);
y1=aug17points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist17=[aug17points(:,1) dist];

clear x* y y1 y2 dist

x1=aug18points(:,2);
y1=aug18points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist18=[aug18points(:,1) dist];

clear x* y y1 y2 dist

x1=aug19points(:,2);
y1=aug19points(:,3);
```

```
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist19=[aug19points(:,1) dist];

clear x* y y1 y2 dist

x1=aug20points(:,2);
y1=aug20points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist20=[aug20points(:,1) dist];

clear x* y y1 y2 dist

x1=aug21points(:,2);
y1=aug21points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist21=[aug21points(:,1) dist];

clear x* y y1 y2 dist

x1=aug22points(:,2);
y1=aug22points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist22=[aug22points(:,1) dist];

clear x* y y1 y2 dist
```

```
x1=aug23points(:,2);
y1=aug23points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist23=[aug23points(:,1) dist];

clear x* y y1 y2 dist

x1=aug24points(:,2);
y1=aug24points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist24=[aug24points(:,1) dist];

clear x* y y1 y2 dist

x1=aug25points(:,2);
y1=aug25points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist25=[aug25points(:,1) dist];

clear x* y y1 y2 dist

x1=aug26points(:,2);
y1=aug26points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist26=[aug26points(:,1) dist];
```

```
clear x* y y1 y2 dist

x1=aug27points(:,2);
y1=aug27points(:,3);
x2=CompCenter(:,1);
y2=CompCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Compschooldist27=[aug27points(:,1) dist];

Compschooldist=[Compschooldist06;Compschooldist07;Compschooldist08;...
   Compschooldist09;Compschooldist10;Compschooldist11;...
   Compschooldist12;Compschooldist13;Compschooldist14;Compschooldist15;...
   Compschooldist16;Compschooldist17;Compschooldist18;Compschooldist19;...
   Compschooldist20;Compschooldist21;Compschooldist22;Compschooldist23;...
   Compschooldist24;Compschooldist25;Compschooldist26;Compschooldist27];

clear x* y y1 y2 dist

%calculate the distance between schooling points and the center of
%G-Deck platform
x1=aug06points(:,2);
y1=aug06points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist06=[aug06points(:,1) dist];

clear x* y y1 y2 dist

x1=aug07points(:,2);
y1=aug07points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist07=[aug07points(:,1) dist];

clear x* y y1 y2 dist
```

```
x1=aug08points(:,2);
y1=aug08points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist08=[aug08points(:,1) dist];

clear x* y y1 y2 dist

x1=aug09points(:,2);
y1=aug09points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist09=[aug09points(:,1) dist];

clear x* y y1 y2 dist

x1=aug10points(:,2);
y1=aug10points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist10=[aug10points(:,1) dist];

clear x* y y1 y2 dist

x1=aug11points(:,2);
y1=aug11points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist11=[aug11points(:,1) dist];
```

```
clear x* y y1 y2 dist

x1=aug12points(:,2);
y1=aug12points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist12=[aug12points(:,1) dist];

clear x* y y1 y2 dist

x1=aug13points(:,2);
y1=aug13points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist13=[aug13points(:,1) dist];

clear x* y y1 y2 dist

x1=aug14points(:,2);
y1=aug14points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist14=[aug14points(:,1) dist];

clear x* y y1 y2 dist

x1=aug15points(:,2);
y1=aug15points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));
```

```
Gschooldist15=[aug15points(:,1) dist];

clear x* y y1 y2 dist

x1=aug16points(:,2);
y1=aug16points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist16=[aug16points(:,1) dist];

clear x* y y1 y2 dist

x1=aug17points(:,2);
y1=aug17points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist17=[aug17points(:,1) dist];

clear x* y y1 y2 dist

x1=aug18points(:,2);
y1=aug18points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist18=[aug18points(:,1) dist];

clear x* y y1 y2 dist

x1=aug19points(:,2);
y1=aug19points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
```

```
dist=sqrt((x.^2)+(y.^2));

Gschooldist19=[aug19points(:,1) dist];

clear x* y y1 y2 dist

x1=aug20points(:,2);
y1=aug20points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist20=[aug20points(:,1) dist];

clear x* y y1 y2 dist

x1=aug21points(:,2);
y1=aug21points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist21=[aug21points(:,1) dist];

clear x* y y1 y2 dist

x1=aug22points(:,2);
y1=aug22points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist22=[aug22points(:,1) dist];

clear x* y y1 y2 dist

x1=aug23points(:,2);
y1=aug23points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);
```

```
x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist23=[aug23points(:,1) dist];

clear x* y y1 y2 dist

x1=aug24points(:,2);
y1=aug24points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist24=[aug24points(:,1) dist];

clear x* y y1 y2 dist

x1=aug25points(:,2);
y1=aug25points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist25=[aug25points(:,1) dist];

clear x* y y1 y2 dist

x1=aug26points(:,2);
y1=aug26points(:,3);
x2=GCenter(:,1);
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist26=[aug26points(:,1) dist];

clear x* y y1 y2 dist

x1=aug27points(:,2);
y1=aug27points(:,3);
x2=GCenter(:,1);
```

```
y2=GCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Gschooldist27=[aug27points(:,1) dist];

Gschooldist=[Gschooldist06;Gschooldist07;Gschooldist08;Gschooldist09;...
    Gschooldist10;Gschooldist11;...
    Gschooldist12;Gschooldist13;Gschooldist14;Gschooldist15;Gschooldist16;...
    Gschooldist17;Gschooldist18;Gschooldist19;Gschooldist20;...
    Gschooldist21;Gschooldist22;Gschooldist23;Gschooldist24;...
    Gschooldist25;Gschooldist26;Gschooldist27];

clear x* y y1 y2 dist

%calculate the distance between schooling points and the center of
%Yankee platform
x1=aug06points(:,2);
y1=aug06points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist06=[aug06points(:,1) dist];

clear x* y y1 y2 dist

x1=aug07points(:,2);
y1=aug07points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist07=[aug07points(:,1) dist];

clear x* y y1 y2 dist

x1=aug08points(:,2);
y1=aug08points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);
```

```
x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist08=[aug08points(:,1) dist];

clear x* y y1 y2 dist

x1=aug09points(:,2);
y1=aug09points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist09=[aug09points(:,1) dist];

clear x* y y1 y2 dist

x1=aug10points(:,2);
y1=aug10points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist10=[aug10points(:,1) dist];

clear x* y y1 y2 dist

x1=aug11points(:,2);
y1=aug11points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist11=[aug11points(:,1) dist];

clear x* y y1 y2 dist

x1=aug12points(:,2);
y1=aug12points(:,3);
x2=YCenter(:,1);
```

```
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist12=[aug12points(:,1) dist];

clear x* y y1 y2 dist

x1=aug13points(:,2);
y1=aug13points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist13=[aug13points(:,1) dist];

clear x* y y1 y2 dist

x1=aug14points(:,2);
y1=aug14points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist14=[aug14points(:,1) dist];

clear x* y y1 y2 dist

x1=aug15points(:,2);
y1=aug15points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist15=[aug15points(:,1) dist];

clear x* y y1 y2 dist

x1=aug16points(:,2);
```

```
y1=aug16points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist16=[aug16points(:,1) dist];

clear x* y y1 y2 dist

x1=aug17points(:,2);
y1=aug17points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist17=[aug17points(:,1) dist];

clear x* y y1 y2 dist

x1=aug18points(:,2);
y1=aug18points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist18=[aug18points(:,1) dist];

clear x* y y1 y2 dist

x1=aug19points(:,2);
y1=aug19points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist19=[aug19points(:,1) dist];

clear x* y y1 y2 dist
```

```
x1=aug20points(:,2);
y1=aug20points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist20=[aug20points(:,1) dist];

clear x* y y1 y2 dist

x1=aug21points(:,2);
y1=aug21points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist21=[aug21points(:,1) dist];

clear x* y y1 y2 dist

x1=aug22points(:,2);
y1=aug22points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist22=[aug22points(:,1) dist];

clear x* y y1 y2 dist

x1=aug23points(:,2);
y1=aug23points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist23=[aug23points(:,1) dist];
```

```
clear x* y y1 y2 dist

x1=aug24points(:,2);
y1=aug24points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist24=[aug24points(:,1) dist];

clear x* y y1 y2 dist

x1=aug25points(:,2);
y1=aug25points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist25=[aug25points(:,1) dist];

clear x* y y1 y2 dist

x1=aug26points(:,2);
y1=aug26points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));

Yschooldist26=[aug26points(:,1) dist];

clear x* y y1 y2 dist

x1=aug27points(:,2);
y1=aug27points(:,3);
x2=YCenter(:,1);
y2=YCenter(:,2);

x=x1-x2;
y=y1-y2;
dist=sqrt((x.^2)+(y.^2));
```

```
Yschooldist27=[aug27points(:,1) dist];

Yschooldist=[Yschooldist06;Yschooldist07;Yschooldist08;Yschooldist09;...
    Yschooldist10;Yschooldist11;...
    Yschooldist12;Yschooldist13;Yschooldist14;Yschooldist15;Yschooldist16;...
    Yschooldist17;Yschooldist18;Yschooldist19;Yschooldist20;...
    Yschooldist21;Yschooldist22;Yschooldist23;Yschooldist24;...
    Yschooldist25;Yschooldist26;Yschooldist27];

clear x* y y1 y2 dist

%separate the data into day and night based on USNO sunrise/sunset data.
%day is defined as 1/2 after sunrise to 1/2 hour before sunset.
%night is defined as 1/2 hour after sunset to 1/2 hour before sunrise.
k=find(OQschooldist06(:,1)<=(0.2049*86400));
j=find(OQschooldist06(:,1)>=(0.8042*86400));
OQnight=[OQschooldist06(k,:);OQschooldist06(j,:)];
aug06night=[OQschooldist06(k,:);OQschooldist06(j,:)];

k=find(OQschooldist07(:,1)<=(0.2056*86400));
j=find(OQschooldist07(:,1)>=(0.8035*86400));
OQnight=[OQschooldist07(k,:);OQschooldist07(j,:)];
aug07night=[OQschooldist07(k,:);OQschooldist07(j,:)];

k=find(OQschooldist08(:,1)<=(0.2062*86400));
j=find(OQschooldist08(:,1)>=(0.8035*86400));
OQnight=[OQschooldist08(k,:);OQschooldist08(j,:)];
aug08night=[OQschooldist08(k,:);OQschooldist08(j,:)];

k=find(OQschooldist09(:,1)<=(0.2062*86400));
j=find(OQschooldist09(:,1)>=(0.8028*86400));
OQnight=[OQnight;OQschooldist09(k,:);OQschooldist09(j,:)];
aug09night=[OQschooldist09(k,:);OQschooldist09(j,:)];

k=find(OQschooldist10(:,1)<=(0.2062*86400));
j=find(OQschooldist10(:,1)>=(0.8021*86400));
OQnight=[OQnight;OQschooldist10(k,:);OQschooldist10(j,:)];
aug10night=[OQschooldist10(k,:);OQschooldist10(j,:)];

k=find(OQschooldist11(:,1)<=(0.2069*86400));
j=find(OQschooldist11(:,1)>=(0.8021*86400));
OQnight=[OQnight;OQschooldist11(k,:);OQschooldist11(j,:)];
aug11night=[OQschooldist11(k,:);OQschooldist11(j,:)];

k=find(OQschooldist12(:,1)<=(0.2069*86400));
j=find(OQschooldist12(:,1)>=(0.8014*86400));
OQnight=[OQnight;OQschooldist12(k,:);OQschooldist12(j,:)];
aug12night=[OQschooldist12(k,:);OQschooldist12(j,:)];
```

```
k=find(OQschooldist13(:,1)<=(0.2076*86400));
j=find(OQschooldist13(:,1)>=(0.8007*86400));
OQnight=[OQnight;OQschooldist13(k,:);OQschooldist13(j,:)];
aug13night=[OQschooldist13(k,:);OQschooldist13(j,:)];

k=find(OQschooldist14(:,1)<=(0.2076*86400));
j=find(OQschooldist14(:,1)>=(0.8000*86400));
OQnight=[OQnight;OQschooldist14(k,:);OQschooldist14(j,:)];
aug14night=[OQschooldist14(k,:);OQschooldist14(j,:)];

k=find(OQschooldist15(:,1)<=(0.2083*86400));
j=find(OQschooldist15(:,1)>=(0.7993*86400));
OQnight=[OQnight;OQschooldist15(k,:);OQschooldist15(j,:)];
aug15night=[OQschooldist15(k,:);OQschooldist15(j,:)];

k=find(OQschooldist16(:,1)<=(0.2083*86400));
j=find(OQschooldist16(:,1)>=(0.7986*86400));
OQnight=[OQnight;OQschooldist16(k,:);OQschooldist16(j,:)];
aug16night=[OQschooldist16(k,:);OQschooldist16(j,:)];

k=find(OQschooldist17(:,1)<=(0.2090*86400));
j=find(OQschooldist17(:,1)>=(0.7979*86400));
OQnight=[OQnight;OQschooldist17(k,:);OQschooldist17(j,:)];
aug17night=[OQschooldist17(k,:);OQschooldist17(j,:)];

k=find(OQschooldist18(:,1)<=(0.2090*86400));
j=find(OQschooldist18(:,1)>=(0.7972*86400));
OQnight=[OQnight;OQschooldist18(k,:);OQschooldist18(j,:)];
aug18night=[OQschooldist18(k,:);OQschooldist18(j,:)];

k=find(OQschooldist19(:,1)<=(0.2097*86400));
j=find(OQschooldist19(:,1)>=(0.7965*86400));
OQnight=[OQnight;OQschooldist19(k,:);OQschooldist19(j,:)];
aug19night=[OQschooldist19(k,:);OQschooldist19(j,:)];

k=find(OQschooldist20(:,1)<=(0.2104*86400));
j=find(OQschooldist20(:,1)>=(0.7958*86400));
OQnight=[OQnight;OQschooldist20(k,:);OQschooldist20(j,:)];
aug20night=[OQschooldist20(k,:);OQschooldist20(j,:)];

k=find(OQschooldist21(:,1)<=(0.2104*86400));
j=find(OQschooldist21(:,1)>=(0.7951*86400));
OQnight=[OQnight;OQschooldist21(k,:);OQschooldist21(j,:)];
aug21night=[OQschooldist21(k,:);OQschooldist21(j,:)];

k=find(OQschooldist22(:,1)<=(0.2111*86400));
j=find(OQschooldist22(:,1)>=(0.7944*86400));
OQnight=[OQnight;OQschooldist22(k,:);OQschooldist22(j,:)];
aug22night=[OQschooldist22(k,:);OQschooldist22(j,:)];
```

```
k=find(OQschooldist23(:,1)<=(0.2111*86400));
j=find(OQschooldist23(:,1)>=(0.7938*86400));
OQnight=[OQnight;OQschooldist23(k,:);OQschooldist23(j,:)];
aug23night=[OQschooldist23(k,:);OQschooldist23(j,:)];

k=find(OQschooldist24(:,1)<=(0.2118*86400));
j=find(OQschooldist24(:,1)>=(0.7931*86400));
OQnight=[OQnight;OQschooldist24(k,:);OQschooldist24(j,:)];
aug24night=[OQschooldist24(k,:);OQschooldist24(j,:)];

k=find(OQschooldist25(:,1)<=(0.2118*86400));
j=find(OQschooldist25(:,1)>=(0.7924*86400));
OQnight=[OQnight;OQschooldist25(k,:);OQschooldist25(j,:)];
aug25night=[OQschooldist25(k,:);OQschooldist25(j,:)];

k=find(OQschooldist26(:,1)<=(0.2125*86400));
j=find(OQschooldist26(:,1)>=(0.7917*86400));
OQnight=[OQnight;OQschooldist26(k,:);OQschooldist26(j,:)];
aug26night=[OQschooldist26(k,:);OQschooldist26(j,:)];

k=find(OQschooldist27(:,1)<=(0.2125*86400));
j=find(OQschooldist27(:,1)>=(0.7910*86400));
OQnight=[OQnight;OQschooldist27(k,:);OQschooldist27(j,:)];
aug27night=[OQschooldist27(k,:);OQschooldist27(j,:)];

k=find(P1schooldist06(:,1)<=(0.2049*86400));
j=find(P1schooldist06(:,1)>=(0.8042*86400));
P1night=[P1schooldist06(k,:);P1schooldist06(j,:)];
aug06night=[aug06night;P1schooldist06(k,:);P1schooldist06(j,:)];

k=find(P1schooldist07(:,1)<=(0.2056*86400));
j=find(P1schooldist07(:,1)>=(0.8035*86400));
P1night=[P1schooldist07(k,:);P1schooldist07(j,:)];
aug07night=[aug07night;P1schooldist07(k,:);P1schooldist07(j,:)];

k=find(P1schooldist08(:,1)<=(0.2062*86400));
j=find(P1schooldist08(:,1)>=(0.8028*86400));
P1night=[P1schooldist08(k,:);P1schooldist08(j,:)];
aug08night=[aug08night;P1schooldist08(k,:);P1schooldist08(j,:)];

k=find(P1schooldist09(:,1)<=(0.2062*86400));
j=find(P1schooldist09(:,1)>=(0.8021*86400));
P1night=[P1night;P1schooldist09(k,:);P1schooldist09(j,:)];
aug09night=[aug09night;P1schooldist09(k,:);P1schooldist09(j,:)];

k=find(P1schooldist10(:,1)<=(0.2062*86400));
j=find(P1schooldist10(:,1)>=(0.8021*86400));
P1night=[P1night;P1schooldist10(k,:);P1schooldist10(j,:)];
aug10night=[aug10night;P1schooldist10(k,:);P1schooldist10(j,:)];
```

```
k=find(P1schooldist11(:,1)<=(0.2069*86400));
j=find(P1schooldist11(:,1)>=(0.8021*86400));
P1night=[P1night;P1schooldist11(k,:);P1schooldist11(j,:)];
aug11night=[aug11night;P1schooldist11(k,:);P1schooldist11(j,:)];

k=find(P1schooldist12(:,1)<=(0.2069*86400));
j=find(P1schooldist12(:,1)>=(0.8014*86400));
P1night=[P1night;P1schooldist12(k,:);P1schooldist12(j,:)];
aug12night=[aug12night;P1schooldist12(k,:);P1schooldist12(j,:)];

k=find(P1schooldist13(:,1)<=(0.2076*86400));
j=find(P1schooldist13(:,1)>=(0.8007*86400));
P1night=[P1night;P1schooldist13(k,:);P1schooldist13(j,:)];
aug13night=[aug13night;P1schooldist13(k,:);P1schooldist13(j,:)];

k=find(P1schooldist14(:,1)<=(0.2076*86400));
j=find(P1schooldist14(:,1)>=(0.8000*86400));
P1night=[P1night;P1schooldist14(k,:);P1schooldist14(j,:)];
aug14night=[aug14night;P1schooldist14(k,:);P1schooldist14(j,:)];

k=find(P1schooldist15(:,1)<=(0.2083*86400));
j=find(P1schooldist15(:,1)>=(0.7993*86400));
P1night=[P1night;P1schooldist15(k,:);P1schooldist15(j,:)];
aug15night=[aug15night;P1schooldist15(k,:);P1schooldist15(j,:)];

k=find(P1schooldist16(:,1)<=(0.2083*86400));
j=find(P1schooldist16(:,1)>=(0.7986*86400));
P1night=[P1night;P1schooldist16(k,:);P1schooldist16(j,:)];
aug16night=[aug16night;P1schooldist16(k,:);P1schooldist16(j,:)];

k=find(P1schooldist17(:,1)<=(0.2090*86400));
j=find(P1schooldist17(:,1)>=(0.7979*86400));
P1night=[P1night;P1schooldist17(k,:);P1schooldist17(j,:)];
aug17night=[aug17night;P1schooldist17(k,:);P1schooldist17(j,:)];

k=find(P1schooldist18(:,1)<=(0.2090*86400));
j=find(P1schooldist18(:,1)>=(0.7972*86400));
P1night=[P1night;P1schooldist18(k,:);P1schooldist18(j,:)];
aug18night=[aug18night;P1schooldist18(k,:);P1schooldist18(j,:)];

k=find(P1schooldist19(:,1)<=(0.2097*86400));
j=find(P1schooldist19(:,1)>=(0.7965*86400));
P1night=[P1night;P1schooldist19(k,:);P1schooldist19(j,:)];
aug19night=[aug19night;P1schooldist19(k,:);P1schooldist19(j,:)];

k=find(P1schooldist20(:,1)<=(0.2104*86400));
j=find(P1schooldist20(:,1)>=(0.7958*86400));
P1night=[P1night;P1schooldist20(k,:);P1schooldist20(j,:)];
aug20night=[aug20night;P1schooldist20(k,:);P1schooldist20(j,:)];
```

```
k=find(P1schooldist21(:,1)<=(0.2104*86400));
j=find(P1schooldist21(:,1)>=(0.7951*86400));
P1night=[P1night;P1schooldist21(k,:);P1schooldist21(j,:)];
aug21night=[aug21night;P1schooldist21(k,:);P1schooldist21(j,:)];

k=find(P1schooldist22(:,1)<=(0.2111*86400));
j=find(P1schooldist22(:,1)>=(0.7944*86400));
P1night=[P1night;P1schooldist22(k,:);P1schooldist22(j,:)];
aug22night=[aug22night;P1schooldist22(k,:);P1schooldist22(j,:)];

k=find(P1schooldist23(:,1)<=(0.2111*86400));
j=find(P1schooldist23(:,1)>=(0.7938*86400));
P1night=[P1night;P1schooldist23(k,:);P1schooldist23(j,:)];
aug23night=[aug23night;P1schooldist23(k,:);P1schooldist23(j,:)];

k=find(P1schooldist24(:,1)<=(0.2118*86400));
j=find(P1schooldist24(:,1)>=(0.7931*86400));
P1night=[P1night;P1schooldist24(k,:);P1schooldist24(j,:)];
aug24night=[aug24night;P1schooldist24(k,:);P1schooldist24(j,:)];

k=find(P1schooldist25(:,1)<=(0.2118*86400));
j=find(P1schooldist25(:,1)>=(0.7924*86400));
P1night=[P1night;P1schooldist25(k,:);P1schooldist25(j,:)];
aug25night=[aug25night;P1schooldist25(k,:);P1schooldist25(j,:)];

k=find(P1schooldist26(:,1)<=(0.2125*86400));
j=find(P1schooldist26(:,1)>=(0.7917*86400));
P1night=[P1night;P1schooldist26(k,:);P1schooldist26(j,:)];
aug26night=[aug26night;P1schooldist26(k,:);P1schooldist26(j,:)];

k=find(P1schooldist27(:,1)<=(0.2125*86400));
j=find(P1schooldist27(:,1)>=(0.7910*86400));
P1night=[P1night;P1schooldist27(k,:);P1schooldist27(j,:)];
aug27night=[aug27night;P1schooldist27(k,:);P1schooldist27(j,:)];

k=find(P2schooldist06(:,1)<=(0.2049*86400));
j=find(P2schooldist06(:,1)>=(0.8042*86400));
P2night=[P2schooldist06(k,:);P2schooldist06(j,:)];
aug06night=[aug06night;P2schooldist06(k,:);P2schooldist06(j,:)];

k=find(P2schooldist07(:,1)<=(0.2056*86400));
j=find(P2schooldist07(:,1)>=(0.8036*86400));
P2night=[P2schooldist07(k,:);P2schooldist07(j,:)];
aug07night=[aug07night;P2schooldist07(k,:);P2schooldist07(j,:)];

k=find(P2schooldist08(:,1)<=(0.2062*86400));
j=find(P2schooldist08(:,1)>=(0.8028*86400));
P2night=[P2schooldist08(k,:);P2schooldist08(j,:)];
aug08night=[aug08night;P2schooldist08(k,:);P2schooldist08(j,:)];
```

```
k=find(P2schooldist09(:,1)<=(0.2062*86400));
j=find(P2schooldist09(:,1)>=(0.8021*86400));
P2night=[P2night;P2schooldist09(k,:);P2schooldist09(j,:)];
aug09night=[aug09night;P2schooldist09(k,:);P2schooldist09(j,:)];

k=find(P2schooldist10(:,1)<=(0.2062*86400));
j=find(P2schooldist10(:,1)>=(0.8021*86400));
P2night=[P2night;P2schooldist10(k,:);P2schooldist10(j,:)];
aug10night=[aug10night;P2schooldist10(k,:);P2schooldist10(j,:)];

k=find(P2schooldist11(:,1)<=(0.2069*86400));
j=find(P2schooldist11(:,1)>=(0.8021*86400));
P2night=[P2night;P2schooldist11(k,:);P2schooldist11(j,:)];
aug11night=[aug11night;P2schooldist11(k,:);P2schooldist11(j,:)];

k=find(P2schooldist12(:,1)<=(0.2069*86400));
j=find(P2schooldist12(:,1)>=(0.8014*86400));
P2night=[P2night;P2schooldist12(k,:);P2schooldist12(j,:)];
aug12night=[aug12night;P2schooldist12(k,:);P2schooldist12(j,:)];

k=find(P2schooldist13(:,1)<=(0.2076*86400));
j=find(P2schooldist13(:,1)>=(0.8007*86400));
P2night=[P2night;P2schooldist13(k,:);P2schooldist13(j,:)];
aug13night=[aug13night;P2schooldist13(k,:);P2schooldist13(j,:)];

k=find(P2schooldist14(:,1)<=(0.2076*86400));
j=find(P2schooldist14(:,1)>=(0.8000*86400));
P2night=[P2night;P2schooldist14(k,:);P2schooldist14(j,:)];
aug14night=[aug14night;P2schooldist14(k,:);P2schooldist14(j,:)];

k=find(P2schooldist15(:,1)<=(0.2083*86400));
j=find(P2schooldist15(:,1)>=(0.7993*86400));
P2night=[P2night;P2schooldist15(k,:);P2schooldist15(j,:)];
aug15night=[aug15night;P2schooldist15(k,:);P2schooldist15(j,:)];

k=find(P2schooldist16(:,1)<=(0.2083*86400));
j=find(P2schooldist16(:,1)>=(0.7986*86400));
P2night=[P2night;P2schooldist16(k,:);P2schooldist16(j,:)];
aug16night=[aug16night;P2schooldist16(k,:);P2schooldist16(j,:)];

k=find(P2schooldist17(:,1)<=(0.2090*86400));
j=find(P2schooldist17(:,1)>=(0.7979*86400));
P2night=[P2night;P2schooldist17(k,:);P2schooldist17(j,:)];
aug17night=[aug17night;P2schooldist17(k,:);P2schooldist17(j,:)];

k=find(P2schooldist18(:,1)<=(0.2090*86400));
j=find(P2schooldist18(:,1)>=(0.7972*86400));
P2night=[P2night;P2schooldist18(k,:);P2schooldist18(j,:)];
aug18night=[aug18night;P2schooldist18(k,:);P2schooldist18(j,:)];
```

```
k=find(P2schooldist19(:,1)<=(0.2097*86400));
j=find(P2schooldist19(:,1)>=(0.7965*86400));
P2night=[P2night;P2schooldist19(k,:);P2schooldist19(j,:)];
aug19night=[aug19night;P2schooldist19(k,:);P2schooldist19(j,:)];

k=find(P2schooldist20(:,1)<=(0.2104*86400));
j=find(P2schooldist20(:,1)>=(0.7958*86400));
P2night=[P2night;P2schooldist20(k,:);P2schooldist20(j,:)];
aug20night=[aug20night;P2schooldist20(k,:);P2schooldist20(j,:)];

k=find(P2schooldist21(:,1)<=(0.2104*86400));
j=find(P2schooldist21(:,1)>=(0.7951*86400));
P2night=[P2night;P2schooldist21(k,:);P2schooldist21(j,:)];
aug21night=[aug21night;P2schooldist21(k,:);P2schooldist21(j,:)];

k=find(P2schooldist22(:,1)<=(0.2111*86400));
j=find(P2schooldist22(:,1)>=(0.7944*86400));
P2night=[P2night;P2schooldist22(k,:);P2schooldist22(j,:)];
aug22night=[aug22night;P2schooldist22(k,:);P2schooldist22(j,:)];

k=find(P2schooldist23(:,1)<=(0.2111*86400));
j=find(P2schooldist23(:,1)>=(0.7938*86400));
P2night=[P2night;P2schooldist23(k,:);P2schooldist23(j,:)];
aug23night=[aug23night;P2schooldist23(k,:);P2schooldist23(j,:)];

k=find(P2schooldist24(:,1)<=(0.2118*86400));
j=find(P2schooldist24(:,1)>=(0.7931*86400));
P2night=[P2night;P2schooldist24(k,:);P2schooldist24(j,:)];
aug24night=[aug24night;P2schooldist24(k,:);P2schooldist24(j,:)];

k=find(P2schooldist25(:,1)<=(0.2118*86400));
j=find(P2schooldist25(:,1)>=(0.7924*86400));
P2night=[P2night;P2schooldist25(k,:);P2schooldist25(j,:)];
aug25night=[aug25night;P2schooldist25(k,:);P2schooldist25(j,:)];

k=find(P2schooldist26(:,1)<=(0.2125*86400));
j=find(P2schooldist26(:,1)>=(0.7917*86400));
P2night=[P2night;P2schooldist26(k,:);P2schooldist26(j,:)];
aug26night=[aug26night;P2schooldist26(k,:);P2schooldist26(j,:)];

k=find(P2schooldist27(:,1)<=(0.2125*86400));
j=find(P2schooldist27(:,1)>=(0.7910*86400));
P2night=[P2night;P2schooldist27(k,:);P2schooldist27(j,:)];
aug27night=[aug27night;P2schooldist27(k,:);P2schooldist27(j,:)];

k=find(Compschooldist06(:,1)<=(0.2049*86400));
j=find(Compschooldist06(:,1)>=(0.8042*86400));
Compnight=[Compschooldist06(k,:);Compschooldist06(j,:)];
aug06night=[aug06night;Compschooldist06(k,:);Compschooldist06(j,:)];
```

```
k=find(Compschooldist07(:,1)<=(0.2056*86400));
j=find(Compschooldist07(:,1)>=(0.8035*86400));
Compnight=[Compschooldist07(k,:);Compschooldist07(j,:)];
aug07night=[aug07night;Compschooldist07(k,:);Compschooldist07(j,:)];

k=find(Compschooldist08(:,1)<=(0.2062*86400));
j=find(Compschooldist08(:,1)>=(0.8028*86400));
Compnight=[Compschooldist08(k,:);Compschooldist08(j,:)];
aug08night=[aug08night;Compschooldist08(k,:);Compschooldist08(j,:)];

k=find(Compschooldist09(:,1)<=(0.2062*86400));
j=find(Compschooldist09(:,1)>=(0.8021*86400));
Compnight=[Compnight;Compschooldist09(k,:);Compschooldist09(j,:)];
aug09night=[aug09night;Compschooldist09(k,:);Compschooldist09(j,:)];

k=find(Compschooldist10(:,1)<=(0.2062*86400));
j=find(Compschooldist10(:,1)>=(0.8021*86400));
Compnight=[Compnight;Compschooldist10(k,:);Compschooldist10(j,:)];
aug10night=[aug10night;Compschooldist10(k,:);Compschooldist10(j,:)];

k=find(Compschooldist11(:,1)<=(0.2069*86400));
j=find(Compschooldist11(:,1)>=(0.8021*86400));
Compnight=[Compnight;Compschooldist11(k,:);Compschooldist11(j,:)];
aug11night=[aug11night;Compschooldist11(k,:);Compschooldist11(j,:)];

k=find(Compschooldist12(:,1)<=(0.2069*86400));
j=find(Compschooldist12(:,1)>=(0.8014*86400));
Compnight=[Compnight;Compschooldist12(k,:);Compschooldist12(j,:)];
aug12night=[aug12night;Compschooldist12(k,:);Compschooldist12(j,:)];

k=find(Compschooldist13(:,1)<=(0.2076*86400));
j=find(Compschooldist13(:,1)>=(0.8007*86400));
Compnight=[Compnight;Compschooldist13(k,:);Compschooldist13(j,:)];
aug13night=[aug13night;Compschooldist13(k,:);Compschooldist13(j,:)];

k=find(Compschooldist14(:,1)<=(0.2076*86400));
j=find(Compschooldist14(:,1)>=(0.8000*86400));
Compnight=[Compnight;Compschooldist14(k,:);Compschooldist14(j,:)];
aug14night=[aug14night;Compschooldist14(k,:);Compschooldist14(j,:)];

k=find(Compschooldist15(:,1)<=(0.2083*86400));
j=find(Compschooldist15(:,1)>=(0.7993*86400));
Compnight=[Compnight;Compschooldist15(k,:);Compschooldist15(j,:)];
aug15night=[aug15night;Compschooldist15(k,:);Compschooldist15(j,:)];

k=find(Compschooldist16(:,1)<=(0.2083*86400));
j=find(Compschooldist16(:,1)>=(0.7986*86400));
Compnight=[Compnight;Compschooldist16(k,:);Compschooldist16(j,:)];
aug16night=[aug16night;Compschooldist16(k,:);Compschooldist16(j,:)];
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```
k=find(Compschooldist17(:,1)<=(0.2090*86400));
j=find(Compschooldist17(:,1)>=(0.7979*86400));
Compnight=[Compnight;Compschooldist17(k,:);Compschooldist17(j,:)];
aug17night=[aug17night;Compschooldist17(k,:);Compschooldist17(j,:)];

k=find(Compschooldist18(:,1)<=(0.2090*86400));
j=find(Compschooldist18(:,1)>=(0.7972*86400));
Compnight=[Compnight;Compschooldist18(k,:);Compschooldist18(j,:)];
aug18night=[aug18night;Compschooldist18(k,:);Compschooldist18(j,:)];

k=find(Compschooldist19(:,1)<=(0.2097*86400));
j=find(Compschooldist19(:,1)>=(0.7965*86400));
Compnight=[Compnight;Compschooldist19(k,:);Compschooldist19(j,:)];
aug19night=[aug19night;Compschooldist19(k,:);Compschooldist19(j,:)];

k=find(Compschooldist20(:,1)<=(0.2104*86400));
j=find(Compschooldist20(:,1)>=(0.7958*86400));
Compnight=[Compnight;Compschooldist20(k,:);Compschooldist20(j,:)];
aug20night=[aug20night;Compschooldist20(k,:);Compschooldist20(j,:)];

k=find(Compschooldist21(:,1)<=(0.2104*86400));
j=find(Compschooldist21(:,1)>=(0.7951*86400));
Compnight=[Compnight;Compschooldist21(k,:);Compschooldist21(j,:)];
aug21night=[aug21night;Compschooldist21(k,:);Compschooldist21(j,:)];

k=find(Compschooldist22(:,1)<=(0.2111*86400));
j=find(Compschooldist22(:,1)>=(0.7944*86400));
Compnight=[Compnight;Compschooldist22(k,:);Compschooldist22(j,:)];
aug22night=[aug22night;Compschooldist22(k,:);Compschooldist22(j,:)];

k=find(Compschooldist23(:,1)<=(0.2111*86400));
j=find(Compschooldist23(:,1)>=(0.7938*86400));
Compnight=[Compnight;Compschooldist23(k,:);Compschooldist23(j,:)];
aug23night=[aug23night;Compschooldist23(k,:);Compschooldist23(j,:)];

k=find(Compschooldist24(:,1)<=(0.2118*86400));
j=find(Compschooldist24(:,1)>=(0.7931*86400));
Compnight=[Compnight;Compschooldist24(k,:);Compschooldist24(j,:)];
aug24night=[aug24night;Compschooldist24(k,:);Compschooldist24(j,:)];

k=find(Compschooldist25(:,1)<=(0.2118*86400));
j=find(Compschooldist25(:,1)>=(0.7924*86400));
Compnight=[Compnight;Compschooldist25(k,:);Compschooldist25(j,:)];
aug25night=[aug25night;Compschooldist25(k,:);Compschooldist25(j,:)];

k=find(Compschooldist26(:,1)<=(0.2125*86400));
j=find(Compschooldist26(:,1)>=(0.7917*86400));
Compnight=[Compnight;Compschooldist26(k,:);Compschooldist26(j,:)];
aug26night=[aug26night;Compschooldist26(k,:);Compschooldist26(j,:)];
```

```
k=find(Compschooldist27(:,1)<=(0.2125*86400));
j=find(Compschooldist27(:,1)>=(0.7910*86400));
Compnight=[Compnight;Compschooldist27(k,:);Compschooldist27(j,:)];
aug27night=[aug27night;Compschooldist27(k,:);Compschooldist27(j,:)];

k=find(Gschooldist06(:,1)<=(0.2049*86400));
j=find(Gschooldist06(:,1)>=(0.8042*86400));
Gnight=[Gschooldist06(k,:);Gschooldist06(j,:)];
aug06night=[aug06night;Gschooldist06(k,:);Gschooldist06(j,:)];

k=find(Gschooldist07(:,1)<=(0.2056*86400));
j=find(Gschooldist07(:,1)>=(0.8035*86400));
Gnight=[Gschooldist07(k,:);Gschooldist07(j,:)];
aug07night=[aug07night;Gschooldist07(k,:);Gschooldist07(j,:)];

k=find(Gschooldist09(:,1)<=(0.2062*86400));
j=find(Gschooldist09(:,1)>=(0.8028*86400));
Gnight=[Gnight;Gschooldist09(k,:);Gschooldist09(j,:)];
aug09night=[aug09night;Gschooldist09(k,:);Gschooldist09(j,:)];

k=find(Gschooldist10(:,1)<=(0.2062*86400));
j=find(Gschooldist10(:,1)>=(0.8021*86400));
Gnight=[Gnight;Gschooldist10(k,:);Gschooldist10(j,:)];
aug10night=[aug10night;Gschooldist10(k,:);Gschooldist10(j,:)];

k=find(Gschooldist11(:,1)<=(0.2069*86400));
j=find(Gschooldist11(:,1)>=(0.8021*86400));
Gnight=[Gnight;Gschooldist11(k,:);Gschooldist11(j,:)];
aug11night=[aug11night;Gschooldist11(k,:);Gschooldist11(j,:)];

k=find(Gschooldist12(:,1)<=(0.2069*86400));
j=find(Gschooldist12(:,1)>=(0.8014*86400));
Gnight=[Gnight;Gschooldist12(k,:);Gschooldist12(j,:)];
aug12night=[aug12night;Gschooldist12(k,:);Gschooldist12(j,:)];

k=find(Gschooldist13(:,1)<=(0.2076*86400));
j=find(Gschooldist13(:,1)>=(0.8007*86400));
Gnight=[Gnight;Gschooldist13(k,:);Gschooldist13(j,:)];
aug13night=[aug13night;Gschooldist13(k,:);Gschooldist13(j,:)];

k=find(Gschooldist14(:,1)<=(0.2076*86400));
j=find(Gschooldist14(:,1)>=(0.8000*86400));
Gnight=[Gnight;Gschooldist14(k,:);Gschooldist14(j,:)];
aug14night=[aug14night;Gschooldist14(k,:);Gschooldist14(j,:)];

k=find(Gschooldist15(:,1)<=(0.2083*86400));
j=find(Gschooldist15(:,1)>=(0.7993*86400));
Gnight=[Gnight;Gschooldist15(k,:);Gschooldist15(j,:)];
aug15night=[aug15night;Gschooldist15(k,:);Gschooldist15(j,:)];
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```
k=find(Gschooldist16(:,1)<=(0.2083*86400));
j=find(Gschooldist16(:,1)>=(0.7986*86400));
Gnight=[Gnight;Gschooldist16(k,:);Gschooldist16(j,:)];
aug16night=[aug16night;Gschooldist16(k,:);Gschooldist16(j,:)];

k=find(Gschooldist17(:,1)<=(0.2090*86400));
j=find(Gschooldist17(:,1)>=(0.7979*86400));
Gnight=[Gnight;Gschooldist17(k,:);Gschooldist17(j,:)];
aug17night=[aug17night;Gschooldist17(k,:);Gschooldist17(j,:)];

k=find(Gschooldist18(:,1)<=(0.2090*86400));
j=find(Gschooldist18(:,1)>=(0.7972*86400));
Gnight=[Gnight;Gschooldist18(k,:);Gschooldist18(j,:)];
aug18night=[aug18night;Gschooldist18(k,:);Gschooldist18(j,:)];

k=find(Gschooldist19(:,1)<=(0.2097*86400));
j=find(Gschooldist19(:,1)>=(0.7965*86400));
Gnight=[Gnight;Gschooldist19(k,:);Gschooldist19(j,:)];
aug19night=[aug19night;Gschooldist19(k,:);Gschooldist19(j,:)];

k=find(Gschooldist20(:,1)<=(0.2104*86400));
j=find(Gschooldist20(:,1)>=(0.7958*86400));
Gnight=[Gnight;Gschooldist20(k,:);Gschooldist20(j,:)];
aug20night=[aug20night;Gschooldist20(k,:);Gschooldist20(j,:)];

k=find(Gschooldist21(:,1)<=(0.2104*86400));
j=find(Gschooldist21(:,1)>=(0.7951*86400));
Gnight=[Gnight;Gschooldist21(k,:);Gschooldist21(j,:)];
aug21night=[aug21night;Gschooldist21(k,:);Gschooldist21(j,:)];

k=find(Gschooldist22(:,1)<=(0.2111*86400));
j=find(Gschooldist22(:,1)>=(0.7944*86400));
Gnight=[Gnight;Gschooldist22(k,:);Gschooldist22(j,:)];
aug22night=[aug22night;Gschooldist22(k,:);Gschooldist22(j,:)];

k=find(Gschooldist23(:,1)<=(0.2111*86400));
j=find(Gschooldist23(:,1)>=(0.7938*86400));
Gnight=[Gnight;Gschooldist23(k,:);Gschooldist23(j,:)];
aug23night=[aug23night;Gschooldist23(k,:);Gschooldist23(j,:)];

k=find(Gschooldist24(:,1)<=(0.2118*86400));
j=find(Gschooldist24(:,1)>=(0.7931*86400));
Gnight=[Gnight;Gschooldist24(k,:);Gschooldist24(j,:)];
aug24night=[aug24night;Gschooldist24(k,:);Gschooldist24(j,:)];

k=find(Gschooldist25(:,1)<=(0.2118*86400));
j=find(Gschooldist25(:,1)>=(0.7924*86400));
Gnight=[Gnight;Gschooldist25(k,:);Gschooldist25(j,:)];
aug25night=[aug25night;Gschooldist25(k,:);Gschooldist25(j,:)];
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```
k=find(Gschooldist26(:,1)<=(0.2125*86400));
j=find(Gschooldist26(:,1)>=(0.7917*86400));
Gnight=[Gnight;Gschooldist26(k,:);Gschooldist26(j,:)];
aug26night=[aug26night;Gschooldist26(k,:);Gschooldist26(j,:)];

k=find(Gschooldist27(:,1)<=(0.2125*86400));
j=find(Gschooldist27(:,1)>=(0.7910*86400));
Gnight=[Gnight;Gschooldist27(k,:);Gschooldist27(j,:)];
aug27night=[aug27night;Gschooldist27(k,:);Gschooldist27(j,:)];

k=find(Yschooldist06(:,1)<=(0.2049*86400));
j=find(Yschooldist06(:,1)>=(0.8042*86400));
Ynight=[Yschooldist06(k,:);Yschooldist06(j,:)];
aug06night=[aug06night;Yschooldist06(k,:);Yschooldist06(j,:)];

k=find(Yschooldist07(:,1)<=(0.2056*86400));
j=find(Yschooldist07(:,1)>=(0.8035*86400));
Ynight=[Yschooldist07(k,:);Yschooldist07(j,:)];
aug07night=[aug07night;Yschooldist07(k,:);Yschooldist07(j,:)];

k=find(Yschooldist08(:,1)<=(0.2062*86400));
j=find(Yschooldist08(:,1)>=(0.8028*86400));
Ynight=[Yschooldist08(k,:);Yschooldist08(j,:)];
aug08night=[aug08night;Yschooldist08(k,:);Yschooldist08(j,:)];

k=find(Yschooldist09(:,1)<=(0.2062*86400));
j=find(Yschooldist09(:,1)>=(0.8021*86400));
Ynight=[Ynight;Yschooldist09(k,:);Yschooldist09(j,:)];
aug09night=[aug09night;Yschooldist09(k,:);Yschooldist09(j,:)];

k=find(Yschooldist10(:,1)<=(0.2062*86400));
j=find(Yschooldist10(:,1)>=(0.8021*86400));
Ynight=[Ynight;Yschooldist10(k,:);Yschooldist10(j,:)];
aug10night=[aug10night;Yschooldist10(k,:);Yschooldist10(j,:)];

k=find(Yschooldist11(:,1)<=(0.2069*86400));
j=find(Yschooldist11(:,1)>=(0.8021*86400));
Ynight=[Ynight;Yschooldist11(k,:);Yschooldist11(j,:)];
aug11night=[aug11night;Yschooldist11(k,:);Yschooldist11(j,:)];

k=find(Yschooldist12(:,1)<=(0.2069*86400));
j=find(Yschooldist12(:,1)>=(0.8014*86400));
Ynight=[Ynight;Yschooldist12(k,:);Yschooldist12(j,:)];
aug12night=[aug12night;Yschooldist12(k,:);Yschooldist12(j,:)];

k=find(Yschooldist13(:,1)<=(0.2076*86400));
j=find(Yschooldist13(:,1)>=(0.8007*86400));
Ynight=[Ynight;Yschooldist13(k,:);Yschooldist13(j,:)];
aug13night=[aug13night;Yschooldist13(k,:);Yschooldist13(j,:)];
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k=find(Yschooldist14(:,1)<=(0.2076*86400));
j=find(Yschooldist14(:,1)>=(0.8000*86400));
Ynight=[Ynight;Yschooldist14(k,:);Yschooldist14(j,:)];
aug14night=[aug14night;Yschooldist14(k,:);Yschooldist14(j,:)];

k=find(Yschooldist15(:,1)<=(0.2083*86400));
j=find(Yschooldist15(:,1)>=(0.7993*86400));
Ynight=[Ynight;Yschooldist15(k,:);Yschooldist15(j,:)];
aug15night=[aug15night;Yschooldist15(k,:);Yschooldist15(j,:)];

k=find(Yschooldist16(:,1)<=(0.2083*86400));
j=find(Yschooldist16(:,1)>=(0.7986*86400));
Ynight=[Ynight;Yschooldist16(k,:);Yschooldist16(j,:)];
aug16night=[aug16night;Yschooldist16(k,:);Yschooldist16(j,:)];

k=find(Yschooldist17(:,1)<=(0.2090*86400));
j=find(Yschooldist17(:,1)>=(0.7979*86400));
Ynight=[Ynight;Yschooldist17(k,:);Yschooldist17(j,:)];
aug17night=[aug17night;Yschooldist17(k,:);Yschooldist17(j,:)];

k=find(Yschooldist18(:,1)<=(0.2090*86400));
j=find(Yschooldist18(:,1)>=(0.7972*86400));
Ynight=[Ynight;Yschooldist18(k,:);Yschooldist18(j,:)];
aug18night=[aug18night;Yschooldist18(k,:);Yschooldist18(j,:)];

k=find(Yschooldist19(:,1)<=(0.2097*86400));
j=find(Yschooldist19(:,1)>=(0.7965*86400));
Ynight=[Ynight;Yschooldist19(k,:);Yschooldist19(j,:)];
aug19night=[aug19night;Yschooldist19(k,:);Yschooldist19(j,:)];

k=find(Yschooldist20(:,1)<=(0.2104*86400));
j=find(Yschooldist20(:,1)>=(0.7958*86400));
Ynight=[Ynight;Yschooldist20(k,:);Yschooldist20(j,:)];
aug20night=[aug20night;Yschooldist20(k,:);Yschooldist20(j,:)];

k=find(Yschooldist21(:,1)<=(0.2104*86400));
j=find(Yschooldist21(:,1)>=(0.7951*86400));
Ynight=[Ynight;Yschooldist21(k,:);Yschooldist21(j,:)];
aug21night=[aug21night;Yschooldist21(k,:);Yschooldist21(j,:)];

k=find(Yschooldist22(:,1)<=(0.2111*86400));
j=find(Yschooldist22(:,1)>=(0.7944*86400));
Ynight=[Ynight;Yschooldist22(k,:);Yschooldist22(j,:)];
aug22night=[aug22night;Yschooldist22(k,:);Yschooldist22(j,:)];

k=find(Yschooldist23(:,1)<=(0.2111*86400));
j=find(Yschooldist23(:,1)>=(0.7938*86400));
Ynight=[Ynight;Yschooldist23(k,:);Yschooldist23(j,:)];
aug23night=[aug23night;Yschooldist23(k,:);Yschooldist23(j,:)];
```

```
k=find(Yschooldist24(:,1)<=(0.2118*86400));
j=find(Yschooldist24(:,1)>=(0.7931*86400));
Ynight=[Ynight;Yschooldist24(k,:);Yschooldist24(j,:)];
aug24night=[aug24night;Yschooldist24(k,:);Yschooldist24(j,:)];

k=find(Yschooldist25(:,1)<=(0.2118*86400));
j=find(Yschooldist25(:,1)>=(0.7924*86400));
Ynight=[Ynight;Yschooldist25(k,:);Yschooldist25(j,:)];
aug25night=[aug25night;Yschooldist25(k,:);Yschooldist25(j,:)];

k=find(Yschooldist26(:,1)<=(0.2125*86400));
j=find(Yschooldist26(:,1)>=(0.7917*86400));
Ynight=[Ynight;Yschooldist26(k,:);Yschooldist26(j,:)];
aug26night=[aug26night;Yschooldist26(k,:);Yschooldist26(j,:)];

k=find(Yschooldist27(:,1)<=(0.2125*86400));
j=find(Yschooldist27(:,1)>=(0.7910*86400));
Ynight=[Ynight;Yschooldist27(k,:);Yschooldist27(j,:)];
aug27night=[aug27night;Yschooldist27(k,:);Yschooldist27(j,:)];

k=find(OQschooldist06(:,1)>=(0.2465*86400) &
(OQschooldist06(:,1)<=(0.7625*86400)));
OQday=OQschooldist06(k,:);
aug06day=OQschooldist06(k,:);

k=find(OQschooldist07(:,1)>=(0.2472*86400) &
(OQschooldist07(:,1)<=(0.7618*86400)));
OQday=OQschooldist07(k,:);
aug07day=OQschooldist07(k,:);

k=find(OQschooldist08(:,1)>=(0.2479*86400) &
(OQschooldist08(:,1)<=(0.7611*86400)));
OQday=OQschooldist08(k,:);
aug08day=OQschooldist08(k,:);

k=find(OQschooldist09(:,1)>=(0.2479*86400) &
(OQschooldist09(:,1)<=(0.7604*86400)));
OQday=[OQday;OQschooldist09(k,:)];
aug09day=OQschooldist09(k,:);

k=find(OQschooldist10(:,1)>=(0.2486*86400) &
(OQschooldist10(:,1)<=(0.7604*86400)));
OQday=[OQday;OQschooldist10(k,:)];
aug10day=OQschooldist10(k,:);

k=find(OQschooldist11(:,1)>=(0.2486*86400) &
(OQschooldist11(:,1)<=(0.7597*86400)));
OQday=[OQday;OQschooldist11(k,:)];
aug11day=OQschooldist11(k,:);
```

```
k=find(OQschooldist12(:,1)>=(0.2493*86400) &
(OQschooldist12(:,1)<=(0.7590*86400)));
OQday=[OQday;OQschooldist12(k,:)];
aug12day=OQschooldist12(k,:);

k=find(OQschooldist13(:,1)>=(0.2493*86400) &
(OQschooldist13(:,1)<=(0.7583*86400)));
OQday=[OQday;OQschooldist13(k,:)];
aug13day=OQschooldist13(k,:);

k=find(OQschooldist14(:,1)>=(0.2500*86400) &
(OQschooldist14(:,1)<=(0.7576*86400)));
OQday=[OQday;OQschooldist14(k,:)];
aug14day=OQschooldist14(k,:);

k=find(OQschooldist15(:,1)>=(0.2500*86400) &
(OQschooldist15(:,1)<=(0.7569*86400)));
OQday=[OQday;OQschooldist15(k,:)];
aug15day=OQschooldist15(k,:);

k=find(OQschooldist16(:,1)>=(0.2507*86400) &
(OQschooldist16(:,1)<=(0.7562*86400)));
OQday=[OQday;OQschooldist16(k,:)];
aug16day=OQschooldist16(k,:);

k=find(OQschooldist17(:,1)>=(0.2507*86400) &
(OQschooldist17(:,1)<=(0.7556*86400)));
OQday=[OQday;OQschooldist17(k,:)];
aug17day=OQschooldist17(k,:);

k=find(OQschooldist18(:,1)>=(0.2514*86400) &
(OQschooldist18(:,1)<=(0.7549*86400)));
OQday=[OQday;OQschooldist18(k,:)];
aug18day=OQschooldist18(k,:);

k=find(OQschooldist19(:,1)>=(0.2521*86400) &
(OQschooldist19(:,1)<=(0.7542*86400)));
OQday=[OQday;OQschooldist19(k,:)];
aug19day=OQschooldist19(k,:);

k=find(OQschooldist20(:,1)>=(0.2521*86400) &
(OQschooldist20(:,1)<=(0.7535*86400)));
OQday=[OQday;OQschooldist20(k,:)];
aug20day=OQschooldist20(k,:);

k=find(OQschooldist21(:,1)>=(0.2528*86400) &
(OQschooldist21(:,1)<=(0.7528*86400)));
OQday=[OQday;OQschooldist21(k,:)];
aug21day=OQschooldist21(k,:);
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```
k=find(OQschooldist22(:,1)>=(0.2528*86400) &
(OQschooldist22(:,1)<=(0.7521*86400)));
OQday=[OQday;OQschooldist22(k,:)];
aug22day=OQschooldist22(k,:);

k=find(OQschooldist23(:,1)>=(0.2535*86400) &
(OQschooldist23(:,1)<=(0.7514*86400)));
OQday=[OQday;OQschooldist23(k,:)];
aug23day=OQschooldist23(k,:);

k=find(OQschooldist24(:,1)>=(0.2535*86400) &
(OQschooldist24(:,1)<=(0.7507*86400)));
OQday=[OQday;OQschooldist24(k,:)];
aug24day=OQschooldist24(k,:);

k=find(OQschooldist25(:,1)>=(0.2542*86400) &
(OQschooldist25(:,1)<=(0.7500*86400)));
OQday=[OQday;OQschooldist25(k,:)];
aug25day=OQschooldist25(k,:);

k=find(OQschooldist26(:,1)>=(0.2542*86400) &
(OQschooldist26(:,1)<=(0.7493*86400)));
OQday=[OQday;OQschooldist26(k,:)];
aug26day=OQschooldist26(k,:);

k=find(OQschooldist27(:,1)>=(0.2549*86400));
OQday=[OQday;OQschooldist27(k,:)];
aug27day=OQschooldist27(k,:);

k=find(P1schooldist06(:,1)>=(0.2465*86400) & (P1schooldist06(:,1)<=(0.7625*86400)));
P1day=P1schooldist06(k,:);
aug06day=[aug06day;P1schooldist06(k,:)];

k=find(P1schooldist07(:,1)>=(0.2472*86400) & (P1schooldist07(:,1)<=(0.7618*86400)));
P1day=P1schooldist07(k,:);
aug07day=[aug07day;P1schooldist07(k,:)];

k=find(P1schooldist08(:,1)>=(0.2479*86400) & (P1schooldist08(:,1)<=(0.7611*86400)));
P1day=P1schooldist08(k,:);
aug08day=[aug08day;P1schooldist08(k,:)];

k=find(P1schooldist09(:,1)>=(0.2479*86400) & (P1schooldist09(:,1)<=(0.7604*86400)));
P1day=[P1day;P1schooldist09(k,:)];
aug09day=[aug09day;P1schooldist09(k,:)];

k=find(P1schooldist10(:,1)>=(0.2486*86400) & (P1schooldist10(:,1)<=(0.7604*86400)));
P1day=[P1day;P1schooldist10(k,:)];
aug10day=[aug10day;P1schooldist10(k,:)];

k=find(P1schooldist11(:,1)>=(0.2486*86400) & (P1schooldist11(:,1)<=(0.7597*86400)));
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```
P1day=[P1day;P1schooldist11(k,:)];
aug11day=[aug11day;P1schooldist11(k,:)];

k=find(P1schooldist12(:,1)>=(0.2493*86400) & (P1schooldist12(:,1)<=(0.7590*86400)));
P1day=[P1day;P1schooldist12(k,:)];
aug12day=[aug12day;P1schooldist12(k,:)];

k=find(P1schooldist13(:,1)>=(0.2493*86400) & (P1schooldist13(:,1)<=(0.7583*86400)));
P1day=[P1day;P1schooldist13(k,:)];
aug13day=[aug13day;P1schooldist13(k,:)];

k=find(P1schooldist14(:,1)>=(0.2500*86400) & (P1schooldist14(:,1)<=(0.7576*86400)));
P1day=[P1day;P1schooldist14(k,:)];
aug14day=[aug14day;P1schooldist14(k,:)];

k=find(P1schooldist15(:,1)>=(0.2500*86400) & (P1schooldist15(:,1)<=(0.7569*86400)));
P1day=[P1day;P1schooldist15(k,:)];
aug15day=[aug15day;P1schooldist15(k,:)];

k=find(P1schooldist16(:,1)>=(0.2507*86400) & (P1schooldist16(:,1)<=(0.7562*86400)));
P1day=[P1day;P1schooldist16(k,:)];
aug16day=[aug16day;P1schooldist16(k,:)];

k=find(P1schooldist17(:,1)>=(0.2507*86400) & (P1schooldist17(:,1)<=(0.7556*86400)));
P1day=[P1day;P1schooldist17(k,:)];
aug17day=[aug17day;P1schooldist17(k,:)];

k=find(P1schooldist18(:,1)>=(0.2514*86400) & (P1schooldist18(:,1)<=(0.7549*86400)));
P1day=[P1day;P1schooldist18(k,:)];
aug18day=[aug18day;P1schooldist18(k,:)];

k=find(P1schooldist19(:,1)>=(0.2521*86400) & (P1schooldist19(:,1)<=(0.7542*86400)));
P1day=[P1day;P1schooldist19(k,:)];
aug19day=[aug19day;P1schooldist19(k,:)];

k=find(P1schooldist20(:,1)>=(0.2521*86400) & (P1schooldist20(:,1)<=(0.7535*86400)));
P1day=[P1day;P1schooldist20(k,:)];
aug20day=[aug20day;P1schooldist20(k,:)];

k=find(P1schooldist21(:,1)>=(0.2528*86400) & (P1schooldist21(:,1)<=(0.7528*86400)));
P1day=[P1day;P1schooldist21(k,:)];
aug21day=[aug21day;P1schooldist21(k,:)];

k=find(P1schooldist22(:,1)>=(0.2528*86400) & (P1schooldist22(:,1)<=(0.7521*86400)));
P1day=[P1day;P1schooldist22(k,:)];
aug22day=[aug22day;P1schooldist22(k,:)];

k=find(P1schooldist23(:,1)>=(0.2535*86400) & (P1schooldist23(:,1)<=(0.7514*86400)));
P1day=[P1day;P1schooldist23(k,:)];
aug23day=[aug23day;P1schooldist23(k,:)];
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k=find(P1schooldist24(:,1)>=(0.2535*86400) & (P1schooldist24(:,1)<=(0.7507*86400)));
P1day=[P1day;P1schooldist24(k,:)];
aug24day=[aug24day;P1schooldist24(k,:)];

k=find(P1schooldist25(:,1)>=(0.2542*86400) & (P1schooldist25(:,1)<=(0.7500*86400)));
P1day=[P1day;P1schooldist25(k,:)];
aug25day=[aug25day;P1schooldist25(k,:)];

k=find(P1schooldist26(:,1)>=(0.2542*86400) & (P1schooldist26(:,1)<=(0.7493*86400)));
P1day=[P1day;P1schooldist26(k,:)];
aug26day=[aug26day;P1schooldist26(k,:)];

k=find(P1schooldist27(:,1)>=(0.2549*86400));
P1day=[P1day;P1schooldist27(k,:)];
aug27day=[aug27day;P1schooldist27(k,:)];

k=find(P2schooldist06(:,1)>=(0.2465*86400) & (P2schooldist06(:,1)<=(0.7625*86400)));
P2day=P2schooldist06(k,:);
aug06day=[aug06day;P2schooldist06(k,:)];

k=find(P2schooldist07(:,1)>=(0.2472*86400) & (P2schooldist07(:,1)<=(0.7618*86400)));
P2day=P2schooldist07(k,:);
aug07day=[aug07day;P2schooldist07(k,:)];

k=find(P2schooldist08(:,1)>=(0.2479*86400) & (P2schooldist08(:,1)<=(0.7611*86400)));
P2day=P2schooldist08(k,:);
aug08day=[aug08day;P2schooldist08(k,:)];

k=find(P2schooldist09(:,1)>=(0.2479*86400) & (P2schooldist09(:,1)<=(0.7604*86400)));
P2day=[P2day;P2schooldist09(k,:)];
aug09day=[aug09day;P2schooldist09(k,:)];

k=find(P2schooldist10(:,1)>=(0.2486*86400) & (P2schooldist10(:,1)<=(0.7604*86400)));
P2day=[P2day;P2schooldist10(k,:)];
aug10day=[aug10day;P2schooldist10(k,:)];

k=find(P2schooldist11(:,1)>=(0.2486*86400) & (P2schooldist11(:,1)<=(0.7597*86400)));
P2day=[P2day;P2schooldist11(k,:)];
aug11day=[aug11day;P2schooldist11(k,:)];

k=find(P2schooldist12(:,1)>=(0.2493*86400) & (P2schooldist12(:,1)<=(0.7590*86400)));
P2day=[P2day;P2schooldist12(k,:)];
aug12day=[aug12day;P2schooldist12(k,:)];

k=find(P2schooldist13(:,1)>=(0.2493*86400) & (P2schooldist13(:,1)<=(0.7583*86400)));
P2day=[P2day;P2schooldist13(k,:)];
aug13day=[aug13day;P2schooldist13(k,:)];

k=find(P2schooldist14(:,1)>=(0.2500*86400) & (P2schooldist14(:,1)<=(0.7576*86400)));
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```
P2day=[P2day;P2schooldist14(k,:)];
aug14day=[aug14day;P2schooldist14(k,:)];

k=find(P2schooldist15(:,1)>=(0.2500*86400) & (P2schooldist15(:,1)<=(0.7569*86400)));
P2day=[P2day;P2schooldist15(k,:)];
aug15day=[aug15day;P2schooldist15(k,:)];

k=find(P2schooldist16(:,1)>=(0.2507*86400) & (P2schooldist16(:,1)<=(0.7562*86400)));
P2day=[P2day;P2schooldist16(k,:)];
aug16day=[aug16day;P2schooldist16(k,:)];

k=find(P2schooldist17(:,1)>=(0.2507*86400) & (P2schooldist17(:,1)<=(0.7556*86400)));
P2day=[P2day;P2schooldist17(k,:)];
aug17day=[aug17day;P2schooldist17(k,:)];

k=find(P2schooldist18(:,1)>=(0.2514*86400) & (P2schooldist18(:,1)<=(0.7549*86400)));
P2day=[P2day;P2schooldist18(k,:)];
aug18day=[aug18day;P2schooldist18(k,:)];

k=find(P2schooldist19(:,1)>=(0.2521*86400) & (P2schooldist19(:,1)<=(0.7542*86400)));
P2day=[P2day;P2schooldist19(k,:)];
aug19day=[aug19day;P2schooldist19(k,:)];

k=find(P2schooldist20(:,1)>=(0.2521*86400) & (P2schooldist20(:,1)<=(0.7535*86400)));
P2day=[P2day;P2schooldist20(k,:)];
aug20day=[aug20day;P2schooldist20(k,:)];

k=find(P2schooldist21(:,1)>=(0.2528*86400) & (P2schooldist21(:,1)<=(0.7528*86400)));
P2day=[P2day;P2schooldist21(k,:)];
aug21day=[aug21day;P2schooldist21(k,:)];

k=find(P2schooldist22(:,1)>=(0.2528*86400) & (P2schooldist22(:,1)<=(0.7521*86400)));
P2day=[P2day;P2schooldist22(k,:)];
aug22day=[aug22day;P2schooldist22(k,:)];

k=find(P2schooldist23(:,1)>=(0.2535*86400) & (P2schooldist23(:,1)<=(0.7514*86400)));
P2day=[P2day;P2schooldist23(k,:)];
aug23day=[aug23day;P2schooldist23(k,:)];

k=find(P2schooldist24(:,1)>=(0.2535*86400) & (P2schooldist24(:,1)<=(0.7507*86400)));
P2day=[P2day;P2schooldist24(k,:)];
aug24day=[aug24day;P2schooldist24(k,:)];

k=find(P2schooldist25(:,1)>=(0.2542*86400) & (P2schooldist25(:,1)<=(0.7500*86400)));
P2day=[P2day;P2schooldist25(k,:)];
aug25day=[aug25day;P2schooldist25(k,:)];

k=find(P2schooldist26(:,1)>=(0.2542*86400) & (P2schooldist26(:,1)<=(0.7493*86400)));
P2day=[P2day;P2schooldist26(k,:)];
aug26day=[aug26day;P2schooldist26(k,:)];
```

```
k=find(P2schooldist27(:,1)>=(0.2549*86400));
P2day=[P2day;P2schooldist27(k,:)];
aug27day=[aug27day;P2schooldist27(k,:)];

k=find(Compschooldist06(:,1)>=(0.2465*86400) &
(Compschooldist06(:,1)<=(0.7625*86400)));
Compday=Compschooldist06(k,:);
aug06day=[aug06day;Compschooldist06(k,:)];

k=find(Compschooldist07(:,1)>=(0.2472*86400) &
(Compschooldist07(:,1)<=(0.7618*86400)));
Compday=Compschooldist07(k,:);
aug07day=[aug07day;Compschooldist07(k,:)];

k=find(Compschooldist08(:,1)>=(0.2479*86400) &
(Compschooldist08(:,1)<=(0.7611*86400)));
Compday=Compschooldist08(k,:);
aug08day=[aug08day;Compschooldist08(k,:)];

k=find(Compschooldist09(:,1)>=(0.2479*86400) &
(Compschooldist09(:,1)<=(0.7604*86400)));
Compday=[Compday;Compschooldist09(k,:)];
aug09day=[aug09day;Compschooldist09(k,:)];

k=find(Compschooldist10(:,1)>=(0.2486*86400) &
(Compschooldist10(:,1)<=(0.7604*86400)));
Compday=[Compday;Compschooldist10(k,:)];
aug10day=[aug10day;Compschooldist10(k,:)];

k=find(Compschooldist11(:,1)>=(0.2486*86400) &
(Compschooldist11(:,1)<=(0.7597*86400)));
Compday=[Compday;Compschooldist11(k,:)];
aug11day=[aug11day;Compschooldist11(k,:)];

k=find(Compschooldist12(:,1)>=(0.2493*86400) &
(Compschooldist12(:,1)<=(0.7590*86400)));
Compday=[Compday;Compschooldist12(k,:)];
aug12day=[aug12day;Compschooldist12(k,:)];

k=find(Compschooldist13(:,1)>=(0.2493*86400) &
(Compschooldist13(:,1)<=(0.7583*86400)));
Compday=[Compday;Compschooldist13(k,:)];
aug13day=[aug13day;Compschooldist13(k,:)];

k=find(Compschooldist14(:,1)>=(0.2500*86400) &
(Compschooldist14(:,1)<=(0.7576*86400)));
Compday=[Compday;Compschooldist14(k,:)];
aug14day=[aug14day;Compschooldist14(k,:)];
```

```
k=find(Compschooldist15(:,1)>=(0.2500*86400) &
(Compschooldist15(:,1)<=(0.7569*86400)));
Compday=[Compday;Compschooldist15(k,:)];
aug15day=[aug15day;Compschooldist15(k,:)];

k=find(Compschooldist16(:,1)>=(0.2507*86400) &
(Compschooldist16(:,1)<=(0.7562*86400)));
Compday=[Compday;Compschooldist16(k,:)];
aug16day=[aug16day;Compschooldist16(k,:)];

k=find(Compschooldist17(:,1)>=(0.2507*86400) &
(Compschooldist17(:,1)<=(0.7556*86400)));
Compday=[Compday;Compschooldist17(k,:)];
aug17day=[aug17day;Compschooldist17(k,:)];

k=find(Compschooldist18(:,1)>=(0.2514*86400) &
(Compschooldist18(:,1)<=(0.7549*86400)));
Compday=[Compday;Compschooldist18(k,:)];
aug18day=[aug18day;Compschooldist18(k,:)];

k=find(Compschooldist19(:,1)>=(0.2521*86400) &
(Compschooldist19(:,1)<=(0.7542*86400)));
Compday=[Compday;Compschooldist19(k,:)];
aug19day=[aug19day;Compschooldist19(k,:)];

k=find(Compschooldist20(:,1)>=(0.2521*86400) &
(Compschooldist20(:,1)<=(0.7535*86400)));
Compday=[Compday;Compschooldist20(k,:)];
aug20day=[aug20day;Compschooldist20(k,:)];

k=find(Compschooldist21(:,1)>=(0.2528*86400) &
(Compschooldist21(:,1)<=(0.7528*86400)));
Compday=[Compday;Compschooldist21(k,:)];
aug21day=[aug21day;Compschooldist21(k,:)];

k=find(Compschooldist22(:,1)>=(0.2528*86400) &
(Compschooldist22(:,1)<=(0.7521*86400)));
Compday=[Compday;Compschooldist22(k,:)];
aug22day=[aug22day;Compschooldist22(k,:)];

k=find(Compschooldist23(:,1)>=(0.2535*86400) &
(Compschooldist23(:,1)<=(0.7514*86400)));
Compday=[Compday;Compschooldist23(k,:)];
aug23day=[aug23day;Compschooldist23(k,:)];

k=find(Compschooldist24(:,1)>=(0.2535*86400) &
(Compschooldist24(:,1)<=(0.7507*86400)));
Compday=[Compday;Compschooldist24(k,:)];
aug24day=[aug24day;Compschooldist24(k,:)];
```

```
k=find(Compschooldist25(:,1)>=(0.2542*86400) &
(Compschooldist25(:,1)<=(0.7500*86400)));
Compday=[Compday;Compschooldist25(k,:)];
aug25day=[aug25day;Compschooldist25(k,:)];

k=find(Compschooldist26(:,1)>=(0.2542*86400) &
(Compschooldist26(:,1)<=(0.7493*86400)));
Compday=[Compday;Compschooldist26(k,:)];
aug26day=[aug26day;Compschooldist26(k,:)];

k=find(Compschooldist27(:,1)>=(0.2549*86400));
Compday=[Compday;Compschooldist27(k,:)];
aug27day=[aug27day;Compschooldist27(k,:)];

k=find(Gschooldist06(:,1)>=(0.2465*86400) & (Gschooldist06(:,1)<=(0.7625*86400)));
Gday=Gschooldist06(k,:);
aug06day=[aug06day;Gschooldist06(k,:)];

k=find(Gschooldist07(:,1)>=(0.2472*86400) & (Gschooldist07(:,1)<=(0.7618*86400)));
Gday=Gschooldist07(k,:);
aug07day=[aug07day;Gschooldist07(k,:)];

k=find(Gschooldist08(:,1)>=(0.2479*86400) & (Gschooldist08(:,1)<=(0.7611*86400)));
Gday=Gschooldist08(k,:);
aug08day=[aug08day;Gschooldist08(k,:)];

k=find(Gschooldist09(:,1)>=(0.2479*86400) & (Gschooldist09(:,1)<=(0.7604*86400)));
Gday=[Gday;Gschooldist09(k,:)];
aug09day=[aug09day;Gschooldist09(k,:)];

k=find(Gschooldist10(:,1)>=(0.2486*86400) & (Gschooldist10(:,1)<=(0.7604*86400)));
Gday=[Gday;Gschooldist10(k,:)];
aug10day=[aug10day;Gschooldist10(k,:)];

k=find(Gschooldist11(:,1)>=(0.2486*86400) & (Gschooldist11(:,1)<=(0.7597*86400)));
Gday=[Gday;Gschooldist11(k,:)];
aug11day=[aug11day;Gschooldist11(k,:)];

k=find(Gschooldist12(:,1)>=(0.2493*86400) & (Gschooldist12(:,1)<=(0.7590*86400)));
Gday=[Gday;Gschooldist12(k,:)];
aug12day=[aug12day;Gschooldist12(k,:)];

k=find(Gschooldist13(:,1)>=(0.2493*86400) & (Gschooldist13(:,1)<=(0.7583*86400)));
Gday=[Gday;Gschooldist13(k,:)];
aug13day=[aug13day;Gschooldist13(k,:)];

k=find(Gschooldist14(:,1)>=(0.2500*86400) & (Gschooldist14(:,1)<=(0.7576*86400)));
Gday=[Gday;Gschooldist14(k,:)];
aug14day=[aug14day;Gschooldist14(k,:)];
```

```
k=find(Gschooldist15(:,1)>=(0.2500*86400) & (Gschooldist15(:,1)<=(0.7569*86400)));
Gday=[Gday;Gschooldist15(k,:)];
aug15day=[aug15day;Gschooldist15(k,:)];

k=find(Gschooldist16(:,1)>=(0.2507*86400) & (Gschooldist16(:,1)<=(0.7562*86400)));
Gday=[Gday;Gschooldist16(k,:)];
aug16day=[aug16day;Gschooldist16(k,:)];

k=find(Gschooldist17(:,1)>=(0.2507*86400) & (Gschooldist17(:,1)<=(0.7556*86400)));
Gday=[Gday;Gschooldist17(k,:)];
aug17day=[aug17day;Gschooldist17(k,:)];

k=find(Gschooldist18(:,1)>=(0.2514*86400) & (Gschooldist18(:,1)<=(0.7549*86400)));
Gday=[Gday;Gschooldist18(k,:)];
aug18day=[aug18day;Gschooldist18(k,:)];

k=find(Gschooldist19(:,1)>=(0.2521*86400) & (Gschooldist19(:,1)<=(0.7542*86400)));
Gday=[Gday;Gschooldist19(k,:)];
aug19day=[aug19day;Gschooldist19(k,:)];

k=find(Gschooldist20(:,1)>=(0.2521*86400) & (Gschooldist20(:,1)<=(0.7535*86400)));
Gday=[Gday;Gschooldist20(k,:)];
aug20day=[aug20day;Gschooldist20(k,:)];

k=find(Gschooldist21(:,1)>=(0.2528*86400) & (Gschooldist21(:,1)<=(0.7528*86400)));
Gday=[Gday;Gschooldist21(k,:)];
aug21day=[aug21day;Gschooldist21(k,:)];

k=find(Gschooldist22(:,1)>=(0.2528*86400) & (Gschooldist22(:,1)<=(0.7521*86400)));
Gday=[Gday;Gschooldist22(k,:)];
aug22day=[aug22day;Gschooldist22(k,:)];

k=find(Gschooldist23(:,1)>=(0.2535*86400) & (Gschooldist23(:,1)<=(0.7514*86400)));
Gday=[Gday;Gschooldist23(k,:)];
aug23day=[aug23day;Gschooldist23(k,:)];

k=find(Gschooldist24(:,1)>=(0.2535*86400) & (Gschooldist24(:,1)<=(0.7507*86400)));
Gday=[Gday;Gschooldist24(k,:)];
aug24day=[aug24day;Gschooldist24(k,:)];

k=find(Gschooldist25(:,1)>=(0.2542*86400) & (Gschooldist25(:,1)<=(0.7500*86400)));
Gday=[Gday;Gschooldist25(k,:)];
aug25day=[aug25day;Gschooldist25(k,:)];

k=find(Gschooldist26(:,1)>=(0.2542*86400) & (Gschooldist26(:,1)<=(0.7493*86400)));
Gday=[Gday;Gschooldist26(k,:)];
aug26day=[aug26day;Gschooldist26(k,:)];

k=find(Gschooldist27(:,1)>=(0.2549*86400));
Gday=[Gday;Gschooldist27(k,:)];
```

```
aug27day=[aug27day;Gschooldist27(k,:)];

k=find(Yschooldist06(:,1)>=(0.2465*86400) & (Yschooldist06(:,1)<=(0.7625*86400)));
Yday=Yschooldist06(k,:);
aug06day=[aug06day;Yschooldist06(k,:)];

k=find(Yschooldist07(:,1)>=(0.2472*86400) & (Yschooldist07(:,1)<=(0.7618*86400)));
Yday=Yschooldist07(k,:);
aug07day=[aug07day;Yschooldist07(k,:)];

k=find(Yschooldist08(:,1)>=(0.2479*86400) & (Yschooldist08(:,1)<=(0.7611*86400)));
Yday=Yschooldist08(k,:);
aug08day=[aug08day;Yschooldist08(k,:)];

k=find(Yschooldist09(:,1)>=(0.2479*86400) & (Yschooldist09(:,1)<=(0.7604*86400)));
Yday=[Yday;Yschooldist09(k,:)];
aug09day=[aug09day;Yschooldist09(k,:)];

k=find(Yschooldist10(:,1)>=(0.2486*86400) & (Yschooldist10(:,1)<=(0.7604*86400)));
Yday=[Yday;Yschooldist10(k,:)];
aug10day=[aug10day;Yschooldist10(k,:)];

k=find(Yschooldist11(:,1)>=(0.2486*86400) & (Yschooldist11(:,1)<=(0.7597*86400)));
Yday=[Yday;Yschooldist11(k,:)];
aug11day=[aug11day;Yschooldist11(k,:)];

k=find(Yschooldist12(:,1)>=(0.2493*86400) & (Yschooldist12(:,1)<=(0.7590*86400)));
Yday=[Yday;Yschooldist12(k,:)];
aug12day=[aug12day;Yschooldist12(k,:)];

k=find(Yschooldist13(:,1)>=(0.2493*86400) & (Yschooldist13(:,1)<=(0.7583*86400)));
Yday=[Yday;Yschooldist13(k,:)];
aug13day=[aug13day;Yschooldist13(k,:)];

k=find(Yschooldist14(:,1)>=(0.2500*86400) & (Yschooldist14(:,1)<=(0.7576*86400)));
Yday=[Yday;Yschooldist14(k,:)];
aug14day=[aug14day;Yschooldist14(k,:)];

k=find(Yschooldist15(:,1)>=(0.2500*86400) & (Yschooldist15(:,1)<=(0.7569*86400)));
Yday=[Yday;Yschooldist15(k,:)];
aug15day=[aug15day;Yschooldist15(k,:)];

k=find(Yschooldist16(:,1)>=(0.2507*86400) & (Yschooldist16(:,1)<=(0.7562*86400)));
Yday=[Yday;Yschooldist16(k,:)];
aug16day=[aug16day;Yschooldist16(k,:)];

k=find(Yschooldist17(:,1)>=(0.2507*86400) & (Yschooldist17(:,1)<=(0.7556*86400)));
Yday=[Yday;Yschooldist17(k,:)];
aug17day=[aug17day;Yschooldist17(k,:)];
```

```
k=find(Yschooldist18(:,1)>=(0.2514*86400) & (Yschooldist18(:,1)<=(0.7549*86400)));
Yday=[Yday;Yschooldist18(k,:)];
aug18day=[aug18day;Yschooldist18(k,:)];

k=find(Yschooldist19(:,1)>=(0.2521*86400) & (Yschooldist19(:,1)<=(0.7542*86400)));
Yday=[Yday;Yschooldist19(k,:)];
aug19day=[aug19day;Yschooldist19(k,:)];

k=find(Yschooldist20(:,1)>=(0.2521*86400) & (Yschooldist20(:,1)<=(0.7535*86400)));
Yday=[Yday;Yschooldist20(k,:)];
aug20day=[aug20day;Yschooldist20(k,:)];

k=find(Yschooldist21(:,1)>=(0.2528*86400) & (Yschooldist21(:,1)<=(0.7528*86400)));
Yday=[Yday;Yschooldist21(k,:)];
aug21day=[aug21day;Yschooldist21(k,:)];

k=find(Yschooldist22(:,1)>=(0.2528*86400) & (Yschooldist22(:,1)<=(0.7521*86400)));
Yday=[Yday;Yschooldist22(k,:)];
aug22day=[aug22day;Yschooldist22(k,:)];

k=find(Yschooldist23(:,1)>=(0.2535*86400) & (Yschooldist23(:,1)<=(0.7514*86400)));
Yday=[Yday;Yschooldist23(k,:)];
aug23day=[aug23day;Yschooldist23(k,:)];

k=find(Yschooldist24(:,1)>=(0.2535*86400) & (Yschooldist24(:,1)<=(0.7507*86400)));
Yday=[Yday;Yschooldist24(k,:)];
aug24day=[aug24day;Yschooldist24(k,:)];

k=find(Yschooldist25(:,1)>=(0.2542*86400) & (Yschooldist25(:,1)<=(0.7500*86400)));
Yday=[Yday;Yschooldist25(k,:)];
aug25day=[aug25day;Yschooldist25(k,:)];

k=find(Yschooldist26(:,1)>=(0.2542*86400) & (Yschooldist26(:,1)<=(0.7493*86400)));
Yday=[Yday;Yschooldist26(k,:)];
aug26day=[aug26day;Yschooldist26(k,:)];

k=find(Yschooldist27(:,1)>=(0.2549*86400));
Yday=[Yday;Yschooldist27(k,:)];
aug27day=[aug27day;Yschooldist27(k,:)];

clear k j

day=[OQday;P1day;P2day;Compday;Gday;Yday];
night=[OQnight;P1night;P2night;Compnight;Gnight;Ynight];

%Perform 2-tailed t-tests to determine if the fish school differently day v.
%night
[dnh,dnsig,dnci,dnstats]=ttest2(day(:,2),night(:,2),0.05,'both');

%Perform 2-tailed t-tests to determine if the fish school differently at
```

```
%different platforms day v.night

[Yh,Ysig,Yci,Ystats]=ttest2(Yday(:,2),Ynight(:,2),0.05,'both');
[P1h,P1sig,P1ci,P1stats]=ttest2(P1day(:,2),P1night(:,2),0.05,'both');
[P2h,P2sig,P2ci,P2stats]=ttest2(P2day(:,2),P2night(:,2),0.05,'both');
[Gh,Gsig,Gci,Gstats]=ttest2(Gday(:,2),Gnight(:,2),0.05,'both');
[OQh,OQsig,OQci,OQstats]=ttest2(OQday(:,2),OQnight(:,2),0.05,'both');
[Comph,Compsig,Compci,Compstats]=ttest2(Compday(:,2),Compnight(:,2),0.05,'both');

clear *ci *Center *06 *07 *08 *09 *10 *11 *12 *13 *14 *15 *16 *17 *18 *19
clear *20 *21 *22 *23 *24 *25 *26 *27
```

schooling36.m

```
if isempty(dist29500);
else
   k=find(dist29500(:,2)<=36);
   if length(k)~=0;
      br29500_br30100(:,1)=dist29500(k,1);
      br29500_br30100(:,2:4)=br29500(k,2:4);
      br29500_br30100(:,5:7)=br30100(k,2:4);
      br29500_br30100(:,8)=dist29500(k,2);
   end
   k=find(dist29500(:,3)<=36);
   if length(k)~=0;
      br29500_br30200(:,1)=dist29500(k,1);
      br29500_br30200(:,2:4)=br29500(k,2:4);
      br29500_br30200(:,5:7)=br30200(k,2:4);
      br29500_br30200(:,8)=dist29500(k,3);
   end

   k=find(dist29500(:,4)<=36);
   if length(k)~=0;
      br29500_br30500(:,1)=dist29500(k,1);
      br29500_br30500(:,2:4)=br29500(k,2:4);
      br29500_br30500(:,5:7)=br30500(k,2:4);
      br29500_br30500(:,8)=dist29500(k,4);
   end

   k=find(dist29500(:,5)<=36);
   if length(k)~=0;
      br29500_br30600(:,1)=dist29500(k,1);
      br29500_br30600(:,2:4)=br29500(k,2:4);
      br29500_br30600(:,5:7)=br30600(k,2:4);
      br29500_br30600(:,8)=dist29500(k,5);
   end

   k=find(dist29500(:,6)<=36);
   if length(k)~=0;
      br29500_br30800(:,1)=dist29500(k,1);
      br29500_br30800(:,2:4)=br29500(k,2:4);
      br29500_br30800(:,5:7)=br30800(k,2:4);
      br29500_br30800(:,8)=dist29500(k,6);
   end

   k=find(dist29500(:,7)<=36);
   if length(k)~=0;
      br29500_br31200(:,1)=dist29500(k,1);
      br29500_br31200(:,2:4)=br29500(k,2:4);
      br29500_br31200(:,5:7)=br31200(k,2:4);
      br29500_br31200(:,8)=dist29500(k,7);
   end
```

```
k=find(dist29500(:,8)<=36);
if length(k)~=0;
   br29500_br31300(:,1)=dist29500(k,1);
   br29500_br31300(:,2:4)=br29500(k,2:4);
   br29500_br31300(:,5:7)=br31300(k,2:4);
   br29500_br31300(:,8)=dist29500(k,8);
end

k=find(dist29500(:,9)<=36);
if length(k)~=0;
   br29500_br31400(:,1)=dist29500(k,1);
   br29500_br31400(:,2:4)=br29500(k,2:4);
   br29500_br31400(:,5:7)=br31400(k,2:4);
   br29500_br31400(:,8)=dist29500(k,9);
end

k=find(dist29500(:,10)<=36);
if length(k)~=0;
   br29500_br31500(:,1)=dist29500(k,1);
   br29500_br31500(:,2:4)=br29500(k,2:4);
   br29500_br31500(:,5:7)=br31500(k,2:4);
   br29500_br31500(:,8)=dist29500(k,10);
end

k=find(dist29500(:,11)<=36);
if length(k)~=0;
   br29500_br31600(:,1)=dist29500(k,1);
   br29500_br31600(:,2:4)=br29500(k,2:4);
   br29500_br31600(:,5:7)=br31600(k,2:4);
   br29500_br31600(:,8)=dist29500(k,11);
end

k=find(dist29500(:,12)<=36);
if length(k)~=0;
   br29500_br31800(:,1)=dist29500(k,1);
   br29500_br31800(:,2:4)=br29500(k,2:4);
   br29500_br31800(:,5:7)=br31800(k,2:4);
   br29500_br31800(:,8)=dist29500(k,12);
end

k=find(dist29500(:,13)<=36);
if length(k)~=0;
   br29500_br32100(:,1)=dist29500(k,1);
   br29500_br32100(:,2:4)=br29500(k,2:4);
   br29500_br32100(:,5:7)=br32100(k,2:4);
   br29500_br32100(:,8)=dist29500(k,13);
end

k=find(dist29500(:,14)<=36);
```

```
if length(k)~=0;
    br29500_br32300(:,1)=dist29500(k,1);
    br29500_br32300(:,2:4)=br29500(k,2:4);
    br29500_br32300(:,5:7)=br32300(k,2:4);
    br29500_br32300(:,8)=dist29500(k,14);
end

k=find(dist29500(:,15)<=36);
if length(k)~=0;
    br29500_br32400(:,1)=dist29500(k,1);
    br29500_br32400(:,2:4)=br29500(k,2:4);
    br29500_br32400(:,5:7)=br32400(k,2:4);
    br29500_br32400(:,8)=dist29500(k,15);
end

k=find(dist29500(:,16)<=36);
if length(k)~=0;
    br29500_br32500(:,1)=dist29500(k,1);
    br29500_br32500(:,2:4)=br29500(k,2:4);
    br29500_br32500(:,5:7)=br32500(k,2:4);
    br29500_br32500(:,8)=dist29500(k,16);
end

k=find(dist29500(:,17)<=36);
if length(k)~=0;
    br29500_br32700(:,1)=dist29500(k,1);
    br29500_br32700(:,2:4)=br29500(k,2:4);
    br29500_br32700(:,5:7)=br32700(k,2:4);
    br29500_br32700(:,8)=dist29500(k,17);
end

k=find(dist29500(:,18)<=36);
if length(k)~=0;
    br29500_br32900(:,1)=dist29500(k,1);
    br29500_br32900(:,2:4)=br29500(k,2:4);
    br29500_br32900(:,5:7)=br32900(k,2:4);
    br29500_br32900(:,8)=dist29500(k,18);
end

k=find(dist29500(:,19)<=36);
if length(k)~=0;
    br29500_br33000(:,1)=dist29500(k,1);
    br29500_br33000(:,2:4)=br29500(k,2:4);
    br29500_br33000(:,5:7)=br33000(k,2:4);
    br29500_br33000(:,8)=dist29500(k,19);
end

k=find(dist29500(:,20)<=36);
if length(k)~=0;
    br29500_br33200(:,1)=dist29500(k,1);
```

```
   br29500_br33200(:,2:4)=br29500(k,2:4);
   br29500_br33200(:,5:7)=br33200(k,2:4);
   br29500_br33200(:,8)=dist29500(k,20);
end

k=find(dist29500(:,21)<=36);
if length(k)~=0;
   br29500_br33300(:,1)=dist29500(k,1);
   br29500_br33300(:,2:4)=br29500(k,2:4);
   br29500_br33300(:,5:7)=br33300(k,2:4);
   br29500_br33300(:,8)=dist29500(k,21);
end

k=find(dist29500(:,22)<=36);
if length(k)~=0;
   br29500_br33500(:,1)=dist29500(k,1);
   br29500_br33500(:,2:4)=br29500(k,2:4);
   br29500_br33500(:,5:7)=br33500(k,2:4);
   br29500_br33500(:,8)=dist29500(k,22);
end

k=find(dist29500(:,23)<=36);
if length(k)~=0;
   br29500_br33600(:,1)=dist29500(k,1);
   br29500_br33600(:,2:4)=br29500(k,2:4);
   br29500_br33600(:,5:7)=br33600(k,2:4);
   br29500_br33600(:,8)=dist29500(k,23);
end

k=find(dist29500(:,24)<=36);
if length(k)~=0;
   br29500_br33700(:,1)=dist29500(k,1);
   br29500_br33700(:,2:4)=br29500(k,2:4);
   br29500_br33700(:,5:7)=br33700(k,2:4);
   br29500_br33700(:,8)=dist29500(k,24);
end

k=find(dist29500(:,25)<=36);
if length(k)~=0;
   br29500_br33800(:,1)=dist29500(k,1);
   br29500_br33800(:,2:4)=br29500(k,2:4);
   br29500_br33800(:,5:7)=br33800(k,2:4);
   br29500_br33800(:,8)=dist29500(k,25);
end

k=find(dist29500(:,26)<=36);
if length(k)~=0;
   br29500_br34000(:,1)=dist29500(k,1);
   br29500_br34000(:,2:4)=br29500(k,2:4);
   br29500_br34000(:,5:7)=br34000(k,2:4);
```

```
    br29500_br34000(:,8)=dist29500(k,26);
end

k=find(dist29500(:,27)<=36);
if length(k)~=0;
    br29500_br34200(:,1)=dist29500(k,1);
    br29500_br34200(:,2:4)=br29500(k,2:4);
    br29500_br34200(:,5:7)=br34200(k,2:4);
    br29500_br34200(:,8)=dist29500(k,27);
end

k=find(dist29500(:,28)<=36);
if length(k)~=0;
    br29500_br34300(:,1)=dist29500(k,1);
    br29500_br34300(:,2:4)=br29500(k,2:4);
    br29500_br34300(:,5:7)=br34300(k,2:4);
    br29500_br34300(:,8)=dist29500(k,28);
end

k=find(dist29500(:,29)<=36);
if length(k)~=0;
    br29500_br34600(:,1)=dist29500(k,1);
    br29500_br34600(:,2:4)=br29500(k,2:4);
    br29500_br34600(:,5:7)=br34600(k,2:4);
    br29500_br34600(:,8)=dist29500(k,29);
end

k=find(dist29500(:,30)<=36);
if length(k)~=0;
    br29500_br34800(:,1)=dist29500(k,1);
    br29500_br34800(:,2:4)=br29500(k,2:4);
    br29500_br34800(:,5:7)=br34800(k,2:4);
    br29500_br34800(:,8)=dist29500(k,30);
end

k=find(dist29500(:,31)<=36);
if length(k)~=0;
    br29500_br34900(:,1)=dist29500(k,1);
    br29500_br34900(:,2:4)=br29500(k,2:4);
    br29500_br34900(:,5:7)=br34900(k,2:4);
    br29500_br34900(:,8)=dist29500(k,31);
end

k=find(dist29500(:,32)<=36);
if length(k)~=0;
    br29500_br35000(:,1)=dist29500(k,1);
    br29500_br35000(:,2:4)=br29500(k,2:4);
    br29500_br35000(:,5:7)=br35000(k,2:4);
    br29500_br35000(:,8)=dist29500(k,32);
end
```

```
end

if isempty(dist30100);
else
   k=find(dist30100(:,3)<=36);
   if length(k)~=0;
      br30100_br30200(:,1)=dist30100(k,1);
      br30100_br30200(:,2:4)=br30100(k,2:4);
      br30100_br30200(:,5:7)=br30200(k,2:4);
      br30100_br30200(:,8)=dist30100(k,3);
   end

   k=find(dist30100(:,4)<=36);
   if length(k)~=0;
      br30100_br30500(:,1)=dist30100(k,1);
      br30100_br30500(:,2:4)=br30100(k,2:4);
      br30100_br30500(:,5:7)=br30500(k,2:4);
      br30100_br30500(:,8)=dist30100(k,4);
   end

   k=find(dist30100(:,5)<=36);
   if length(k)~=0;
      br30100_br30600(:,1)=dist30100(k,1);
      br30100_br30600(:,2:4)=br30100(k,2:4);
      br30100_br30600(:,5:7)=br30600(k,2:4);
      br30100_br30600(:,8)=dist30100(k,5);
   end

   k=find(dist30100(:,6)<=36);
   if length(k)~=0;
      br30100_br30800(:,1)=dist30100(k,1);
      br30100_br30800(:,2:4)=br30100(k,2:4);
      br30100_br30800(:,5:7)=br30800(k,2:4);
      br30100_br30800(:,8)=dist30100(k,6);
   end

   k=find(dist30100(:,7)<=36);
   if length(k)~=0;
      br30100_br31200(:,1)=dist30100(k,1);
      br30100_br31200(:,2:4)=br30100(k,2:4);
      br30100_br31200(:,5:7)=br31200(k,2:4);
      br30100_br31200(:,8)=dist30100(k,7);
   end

   k=find(dist30100(:,8)<=36);
   if length(k)~=0;
      br30100_br31300(:,1)=dist30100(k,1);
      br30100_br31300(:,2:4)=br30100(k,2:4);
      br30100_br31300(:,5:7)=br31300(k,2:4);
      br30100_br31300(:,8)=dist30100(k,8);
```

```
end

k=find(dist30100(:,9)<=36);
if length(k)~=0;
   br30100_br31400(:,1)=dist30100(k,1);
   br30100_br31400(:,2:4)=br30100(k,2:4);
   br30100_br31400(:,5:7)=br31400(k,2:4);
   br30100_br31400(:,8)=dist30100(k,9);
end

k=find(dist30100(:,10)<=36);
if length(k)~=0;
   br30100_br31500(:,1)=dist30100(k,1);
   br30100_br31500(:,2:4)=br30100(k,2:4);
   br30100_br31500(:,5:7)=br31500(k,2:4);
   br30100_br31500(:,8)=dist30100(k,10);
end

k=find(dist30100(:,11)<=36);
if length(k)~=0;
   br30100_br31600(:,1)=dist30100(k,1);
   br30100_br31600(:,2:4)=br30100(k,2:4);
   br30100_br31600(:,5:7)=br31600(k,2:4);
   br30100_br31600(:,8)=dist30100(k,11);
end

k=find(dist30100(:,12)<=36);
if length(k)~=0;
   br30100_br31800(:,1)=dist30100(k,1);
   br30100_br31800(:,2:4)=br30100(k,2:4);
   br30100_br31800(:,5:7)=br31800(k,2:4);
   br30100_br31800(:,8)=dist30100(k,12);
end

k=find(dist30100(:,13)<=36);
if length(k)~=0;
   br30100_br32100(:,1)=dist30100(k,1);
   br30100_br32100(:,2:4)=br30100(k,2:4);
   br30100_br32100(:,5:7)=br32100(k,2:4);
   br30100_br32100(:,8)=dist30100(k,13);
end

k=find(dist30100(:,14)<=36);
if length(k)~=0;
   br30100_br32300(:,1)=dist30100(k,1);
   br30100_br32300(:,2:4)=br30100(k,2:4);
   br30100_br32300(:,5:7)=br32300(k,2:4);
   br30100_br32300(:,8)=dist30100(k,14);
end
```

```
k=find(dist30100(:,15)<=36);
if length(k)~=0;
   br30100_br32400(:,1)=dist30100(k,1);
   br30100_br32400(:,2:4)=br30100(k,2:4);
   br30100_br32400(:,5:7)=br32400(k,2:4);
   br30100_br32400(:,8)=dist30100(k,15);
end

k=find(dist30100(:,16)<=36);
if length(k)~=0;
   br30100_br32500(:,1)=dist30100(k,1);
   br30100_br32500(:,2:4)=br30100(k,2:4);
   br30100_br32500(:,5:7)=br32500(k,2:4);
   br30100_br32500(:,8)=dist30100(k,16);
end

k=find(dist30100(:,17)<=36);
if length(k)~=0;
   br30100_br32700(:,1)=dist30100(k,1);
   br30100_br32700(:,2:4)=br30100(k,2:4);
   br30100_br32700(:,5:7)=br32700(k,2:4);
   br30100_br32700(:,8)=dist30100(k,17);
end

k=find(dist30100(:,18)<=36);
if length(k)~=0;
   br30100_br32900(:,1)=dist30100(k,1);
   br30100_br32900(:,2:4)=br30100(k,2:4);
   br30100_br32900(:,5:7)=br32900(k,2:4);
   br30100_br32900(:,8)=dist30100(k,18);
end

k=find(dist30100(:,19)<=36);
if length(k)~=0;
   br30100_br33000(:,1)=dist30100(k,1);
   br30100_br33000(:,2:4)=br30100(k,2:4);
   br30100_br33000(:,5:7)=br33000(k,2:4);
   br30100_br33000(:,8)=dist30100(k,19);
end

k=find(dist30100(:,20)<=36);
if length(k)~=0;
   br30100_br33200(:,1)=dist30100(k,1);
   br30100_br33200(:,2:4)=br30100(k,2:4);
   br30100_br33200(:,5:7)=br33200(k,2:4);
   br30100_br33200(:,8)=dist30100(k,20);
end

k=find(dist30100(:,21)<=36);
if length(k)~=0;
```

```
    br30100_br33300(:,1)=dist30100(k,1);
    br30100_br33300(:,2:4)=br30100(k,2:4);
    br30100_br33300(:,5:7)=br33300(k,2:4);
    br30100_br33300(:,8)=dist30100(k,21);
end

k=find(dist30100(:,22)<=36);
if length(k)~=0;
    br30100_br33500(:,1)=dist30100(k,1);
    br30100_br33500(:,2:4)=br30100(k,2:4);
    br30100_br33500(:,5:7)=br33500(k,2:4);
    br30100_br33500(:,8)=dist30100(k,22);
end

k=find(dist30100(:,23)<=36);
if length(k)~=0;
    br30100_br33600(:,1)=dist30100(k,1);
    br30100_br33600(:,2:4)=br30100(k,2:4);
    br30100_br33600(:,5:7)=br33600(k,2:4);
    br30100_br33600(:,8)=dist30100(k,23);
end

k=find(dist30100(:,24)<=36);
if length(k)~=0;
    br30100_br33700(:,1)=dist30100(k,1);
    br30100_br33700(:,2:4)=br30100(k,2:4);
    br30100_br33700(:,5:7)=br33700(k,2:4);
    br30100_br33700(:,8)=dist30100(k,24);
end

k=find(dist30100(:,25)<=36);
if length(k)~=0;
    br30100_br33800(:,1)=dist30100(k,1);
    br30100_br33800(:,2:4)=br30100(k,2:4);
    br30100_br33800(:,5:7)=br33800(k,2:4);
    br30100_br33800(:,8)=dist30100(k,25);
end

k=find(dist30100(:,26)<=36);
if length(k)~=0;
    br30100_br34000(:,1)=dist30100(k,1);
    br30100_br34000(:,2:4)=br30100(k,2:4);
    br30100_br34000(:,5:7)=br34000(k,2:4);
    br30100_br34000(:,8)=dist30100(k,26);
end

k=find(dist30100(:,27)<=36);
if length(k)~=0;
    br30100_br34200(:,1)=dist30100(k,1);
    br30100_br34200(:,2:4)=br30100(k,2:4);
```

```
        br30100_br34200(:,5:7)=br34200(k,2:4);
        br30100_br34200(:,8)=dist30100(k,27);
    end

    k=find(dist30100(:,28)<=36);
    if length(k)~=0;
        br30100_br34300(:,1)=dist30100(k,1);
        br30100_br34300(:,2:4)=br30100(k,2:4);
        br30100_br34300(:,5:7)=br34300(k,2:4);
        br30100_br34300(:,8)=dist30100(k,28);
    end

    k=find(dist30100(:,29)<=36);
    if length(k)~=0;
        br30100_br34600(:,1)=dist30100(k,1);
        br30100_br34600(:,2:4)=br30100(k,2:4);
        br30100_br34600(:,5:7)=br34600(k,2:4);
        br30100_br34600(:,8)=dist30100(k,29);
    end

    k=find(dist30100(:,30)<=36);
    if length(k)~=0;
        br30100_br34800(:,1)=dist30100(k,1);
        br30100_br34800(:,2:4)=br30100(k,2:4);
        br30100_br34800(:,5:7)=br34800(k,2:4);
        br30100_br34800(:,8)=dist30100(k,30);
    end

    k=find(dist30100(:,31)<=36);
    if length(k)~=0;
        br30100_br34900(:,1)=dist30100(k,1);
        br30100_br34900(:,2:4)=br30100(k,2:4);
        br30100_br34900(:,5:7)=br34900(k,2:4);
        br30100_br34900(:,8)=dist30100(k,31);
    end

    k=find(dist30100(:,32)<=36);
    if length(k)~=0;
        br30100_br35000(:,1)=dist30100(k,1);
        br30100_br35000(:,2:4)=br30100(k,2:4);
        br30100_br35000(:,5:7)=br35000(k,2:4);
        br30100_br35000(:,8)=dist30100(k,32);
    end
end

if isempty(dist30200);
else
    k=find(dist30200(:,4)<=36);
    if length(k)~=0;
        br30200_br30500(:,1)=dist30200(k,1);
```

```
    br30200_br30500(:,2:4)=br30200(k,2:4);
    br30200_br30500(:,5:7)=br30500(k,2:4);
    br30200_br30500(:,8)=dist30200(k,4);
end

k=find(dist30200(:,5)<=36);
if length(k)~=0;
    br30200_br30600(:,1)=dist30200(k,1);
    br30200_br30600(:,2:4)=br30200(k,2:4);
    br30200_br30600(:,5:7)=br30600(k,2:4);
    br30200_br30600(:,8)=dist30200(k,5);
end

k=find(dist30200(:,6)<=36);
if length(k)~=0;
    br30200_br30800(:,1)=dist30200(k,1);
    br30200_br30800(:,2:4)=br30200(k,2:4);
    br30200_br30800(:,5:7)=br30800(k,2:4);
    br30200_br30800(:,8)=dist30200(k,6);
end

k=find(dist30200(:,7)<=36);
if length(k)~=0;
    br30200_br31200(:,1)=dist30200(k,1);
    br30200_br31200(:,2:4)=br30200(k,2:4);
    br30200_br31200(:,5:7)=br31200(k,2:4);
    br30200_br31200(:,8)=dist30200(k,7);
end

k=find(dist30200(:,8)<=36);
if length(k)~=0;
    br30200_br31300(:,1)=dist30200(k,1);
    br30200_br31300(:,2:4)=br30200(k,2:4);
    br30200_br31300(:,5:7)=br31300(k,2:4);
    br30200_br31300(:,8)=dist30200(k,8);
end

k=find(dist30200(:,9)<=36);
if length(k)~=0;
    br30200_br31400(:,1)=dist30200(k,1);
    br30200_br31400(:,2:4)=br30200(k,2:4);
    br30200_br31400(:,5:7)=br31400(k,2:4);
    br30200_br31400(:,8)=dist30200(k,9);
end

k=find(dist30200(:,10)<=36);
if length(k)~=0;
    br30200_br31500(:,1)=dist30200(k,1);
    br30200_br31500(:,2:4)=br30200(k,2:4);
    br30200_br31500(:,5:7)=br31500(k,2:4);
```

```
    br30200_br31500(:,8)=dist30200(k,10);
end

k=find(dist30200(:,11)<=36);
if length(k)~=0;
    br30200_br31600(:,1)=dist30200(k,1);
    br30200_br31600(:,2:4)=br30200(k,2:4);
    br30200_br31600(:,5:7)=br31600(k,2:4);
    br30200_br31600(:,8)=dist30200(k,11);
end

k=find(dist30200(:,12)<=36);
if length(k)~=0;
    br30200_br31800(:,1)=dist30200(k,1);
    br30200_br31800(:,2:4)=br30200(k,2:4);
    br30200_br31800(:,5:7)=br31800(k,2:4);
    br30200_br31800(:,8)=dist30200(k,12);
end

k=find(dist30200(:,13)<=36);
if length(k)~=0;
    br30200_br32100(:,1)=dist30200(k,1);
    br30200_br32100(:,2:4)=br30200(k,2:4);
    br30200_br32100(:,5:7)=br32100(k,2:4);
    br30200_br32100(:,8)=dist30200(k,13);
end

k=find(dist30200(:,14)<=36);
if length(k)~=0;
    br30200_br32300(:,1)=dist30200(k,1);
    br30200_br32300(:,2:4)=br30200(k,2:4);
    br30200_br32300(:,5:7)=br32300(k,2:4);
    br30200_br32300(:,8)=dist30200(k,14);
end

k=find(dist30200(:,15)<=36);
if length(k)~=0;
    br30200_br32400(:,1)=dist30200(k,1);
    br30200_br32400(:,2:4)=br30200(k,2:4);
    br30200_br32400(:,5:7)=br32400(k,2:4);
    br30200_br32400(:,8)=dist30200(k,15);
end

k=find(dist30200(:,16)<=36);
if length(k)~=0;
    br30200_br32500(:,1)=dist30200(k,1);
    br30200_br32500(:,2:4)=br30200(k,2:4);
    br30200_br32500(:,5:7)=br32500(k,2:4);
    br30200_br32500(:,8)=dist30200(k,16);
end
```

```
k=find(dist30200(:,17)<=36);
if length(k)~=0;
   br30200_br32700(:,1)=dist30200(k,1);
   br30200_br32700(:,2:4)=br30200(k,2:4);
   br30200_br32700(:,5:7)=br32700(k,2:4);
   br30200_br32700(:,8)=dist30200(k,17);
end

k=find(dist30200(:,18)<=36);
if length(k)~=0;
   br30200_br32900(:,1)=dist30200(k,1);
   br30200_br32900(:,2:4)=br30200(k,2:4);
   br30200_br32900(:,5:7)=br32900(k,2:4);
   br30200_br32900(:,8)=dist30200(k,18);
end

k=find(dist30200(:,19)<=36);
if length(k)~=0;
   br30200_br33000(:,1)=dist30200(k,1);
   br30200_br33000(:,2:4)=br30200(k,2:4);
   br30200_br33000(:,5:7)=br33000(k,2:4);
   br30200_br33000(:,8)=dist30200(k,19);
end

k=find(dist30200(:,20)<=36);
if length(k)~=0;
   br30200_br33200(:,1)=dist30200(k,1);
   br30200_br33200(:,2:4)=br30200(k,2:4);
   br30200_br33200(:,5:7)=br33200(k,2:4);
   br30200_br33200(:,8)=dist30200(k,20);
end

k=find(dist30200(:,21)<=36);
if length(k)~=0;
   br30200_br33300(:,1)=dist30200(k,1);
   br30200_br33300(:,2:4)=br30200(k,2:4);
   br30200_br33300(:,5:7)=br33300(k,2:4);
   br30200_br33300(:,8)=dist30200(k,21);
end

k=find(dist30200(:,22)<=36);
if length(k)~=0;
   br30200_br33500(:,1)=dist30200(k,1);
   br30200_br33500(:,2:4)=br30200(k,2:4);
   br30200_br33500(:,5:7)=br33500(k,2:4);
   br30200_br33500(:,8)=dist30200(k,22);
end

k=find(dist30200(:,23)<=36);
```

```
if length(k)~=0;
    br30200_br33600(:,1)=dist30200(k,1);
    br30200_br33600(:,2:4)=br30200(k,2:4);
    br30200_br33600(:,5:7)=br33600(k,2:4);
    br30200_br33600(:,8)=dist30200(k,23);
end

k=find(dist30200(:,24)<=36);
if length(k)~=0;
    br30200_br33700(:,1)=dist30200(k,1);
    br30200_br33700(:,2:4)=br30200(k,2:4);
    br30200_br33700(:,5:7)=br33700(k,2:4);
    br30200_br33700(:,8)=dist30200(k,24);
end

k=find(dist30200(:,25)<=36);
if length(k)~=0;
    br30200_br33800(:,1)=dist30200(k,1);
    br30200_br33800(:,2:4)=br30200(k,2:4);
    br30200_br33800(:,5:7)=br33800(k,2:4);
    br30200_br33800(:,8)=dist30200(k,25);
end

k=find(dist30200(:,26)<=36);
if length(k)~=0;
    br30200_br34000(:,1)=dist30200(k,1);
    br30200_br34000(:,2:4)=br30200(k,2:4);
    br30200_br34000(:,5:7)=br34000(k,2:4);
    br30200_br34000(:,8)=dist30200(k,26);
end

k=find(dist30200(:,27)<=36);
if length(k)~=0;
    br30200_br34200(:,1)=dist30200(k,1);
    br30200_br34200(:,2:4)=br30200(k,2:4);
    br30200_br34200(:,5:7)=br34200(k,2:4);
    br30200_br34200(:,8)=dist30200(k,27);
end

k=find(dist30200(:,28)<=36);
if length(k)~=0;
    br30200_br34300(:,1)=dist30200(k,1);
    br30200_br34300(:,2:4)=br30200(k,2:4);
    br30200_br34300(:,5:7)=br34300(k,2:4);
    br30200_br34300(:,8)=dist30200(k,28);
end

k=find(dist30200(:,29)<=36);
if length(k)~=0;
    br30200_br34600(:,1)=dist30200(k,1);
```

```
        br30200_br34600(:,2:4)=br30200(k,2:4);
        br30200_br34600(:,5:7)=br34600(k,2:4);
        br30200_br34600(:,8)=dist30200(k,29);
    end

    k=find(dist30200(:,30)<=36);
    if length(k)~=0;
        br30200_br34800(:,1)=dist30200(k,1);
        br30200_br34800(:,2:4)=br30200(k,2:4);
        br30200_br34800(:,5:7)=br34800(k,2:4);
        br30200_br34800(:,8)=dist30200(k,30);
    end

    k=find(dist30200(:,31)<=36);
    if length(k)~=0;
        br30200_br34900(:,1)=dist30200(k,1);
        br30200_br34900(:,2:4)=br30200(k,2:4);
        br30200_br34900(:,5:7)=br34900(k,2:4);
        br30200_br34900(:,8)=dist30200(k,31);
    end

    k=find(dist30200(:,32)<=36);
    if length(k)~=0;
        br30200_br35000(:,1)=dist30200(k,1);
        br30200_br35000(:,2:4)=br30200(k,2:4);
        br30200_br35000(:,5:7)=br35000(k,2:4);
        br30200_br35000(:,8)=dist30200(k,32);
    end
end

if isempty(dist30500);
else
    k=find(dist30500(:,5)<=36);
    if length(k)~=0;
        br30500_br30600(:,1)=dist30500(k,1);
        br30500_br30600(:,2:4)=br30500(k,2:4);
        br30500_br30600(:,5:7)=br30600(k,2:4);
        br30500_br30600(:,8)=dist30500(k,5);
    end

    k=find(dist30500(:,6)<=36);
    if length(k)~=0;
        br30500_br30800(:,1)=dist30500(k,1);
        br30500_br30800(:,2:4)=br30500(k,2:4);
        br30500_br30800(:,5:7)=br30800(k,2:4);
        br30500_br30800(:,8)=dist30500(k,6);
    end

    k=find(dist30500(:,7)<=36);
    if length(k)~=0;
```

```
    br30500_br31200(:,1)=dist30500(k,1);
    br30500_br31200(:,2:4)=br30500(k,2:4);
    br30500_br31200(:,5:7)=br31200(k,2:4);
    br30500_br31200(:,8)=dist30500(k,7);
end

k=find(dist30500(:,8)<=36);
if length(k)~=0;
    br30500_br31300(:,1)=dist30500(k,1);
    br30500_br31300(:,2:4)=br30500(k,2:4);
    br30500_br31300(:,5:7)=br31300(k,2:4);
    br30500_br31300(:,8)=dist30500(k,8);
end

k=find(dist30500(:,9)<=36);
if length(k)~=0;
    br30500_br31400(:,1)=dist30500(k,1);
    br30500_br31400(:,2:4)=br30500(k,2:4);
    br30500_br31400(:,5:7)=br31400(k,2:4);
    br30500_br31400(:,8)=dist30500(k,9);
end

k=find(dist30500(:,10)<=36);
if length(k)~=0;
    br30500_br31500(:,1)=dist30500(k,1);
    br30500_br31500(:,2:4)=br30500(k,2:4);
    br30500_br31500(:,5:7)=br31500(k,2:4);
    br30500_br31500(:,8)=dist30500(k,10);
end

k=find(dist30500(:,11)<=36);
if length(k)~=0;
    br30500_br31600(:,1)=dist30500(k,1);
    br30500_br31600(:,2:4)=br30500(k,2:4);
    br30500_br31600(:,5:7)=br31600(k,2:4);
    br30500_br31600(:,8)=dist30500(k,11);
end

k=find(dist30500(:,12)<=36);
if length(k)~=0;
    br30500_br31800(:,1)=dist30500(k,1);
    br30500_br31800(:,2:4)=br30500(k,2:4);
    br30500_br31800(:,5:7)=br31800(k,2:4);
    br30500_br31800(:,8)=dist30500(k,12);
end

k=find(dist30500(:,13)<=36);
if length(k)~=0;
    br30500_br32100(:,1)=dist30500(k,1);
    br30500_br32100(:,2:4)=br30500(k,2:4);
```

```
    br30500_br32100(:,5:7)=br32100(k,2:4);
    br30500_br32100(:,8)=dist30500(k,13);
end

k=find(dist30500(:,14)<=36);
if length(k)~=0;
    br30500_br32300(:,1)=dist30500(k,1);
    br30500_br32300(:,2:4)=br30500(k,2:4);
    br30500_br32300(:,5:7)=br32300(k,2:4);
    br30500_br32300(:,8)=dist30500(k,14);
end

k=find(dist30500(:,15)<=36);
if length(k)~=0;
    br30500_br32400(:,1)=dist30500(k,1);
    br30500_br32400(:,2:4)=br30500(k,2:4);
    br30500_br32400(:,5:7)=br32400(k,2:4);
    br30500_br32400(:,8)=dist30500(k,15);
end

k=find(dist30500(:,16)<=36);
if length(k)~=0;
    br30500_br32500(:,1)=dist30500(k,1);
    br30500_br32500(:,2:4)=br30500(k,2:4);
    br30500_br32500(:,5:7)=br32500(k,2:4);
    br30500_br32500(:,8)=dist30500(k,16);
end

k=find(dist30500(:,17)<=36);
if length(k)~=0;
    br30500_br32700(:,1)=dist30500(k,1);
    br30500_br32700(:,2:4)=br30500(k,2:4);
    br30500_br32700(:,5:7)=br32700(k,2:4);
    br30500_br32700(:,8)=dist30500(k,17);
end

k=find(dist30500(:,18)<=36);
if length(k)~=0;
    br30500_br32900(:,1)=dist30500(k,1);
    br30500_br32900(:,2:4)=br30500(k,2:4);
    br30500_br32900(:,5:7)=br32900(k,2:4);
    br30500_br32900(:,8)=dist30500(k,18);
end

k=find(dist30500(:,19)<=36);
if length(k)~=0;
    br30500_br33000(:,1)=dist30500(k,1);
    br30500_br33000(:,2:4)=br30500(k,2:4);
    br30500_br33000(:,5:7)=br33000(k,2:4);
    br30500_br33000(:,8)=dist30500(k,19);
```

```
end

k=find(dist30500(:,20)<=36);
if length(k)~=0;
   br30500_br33200(:,1)=dist30500(k,1);
   br30500_br33200(:,2:4)=br30500(k,2:4);
   br30500_br33200(:,5:7)=br33200(k,2:4);
   br30500_br33200(:,8)=dist30500(k,20);
end

k=find(dist30500(:,21)<=36);
if length(k)~=0;
   br30500_br33300(:,1)=dist30500(k,1);
   br30500_br33300(:,2:4)=br30500(k,2:4);
   br30500_br33300(:,5:7)=br33300(k,2:4);
   br30500_br33300(:,8)=dist30500(k,21);
end

k=find(dist30500(:,22)<=36);
if length(k)~=0;
   br30500_br33500(:,1)=dist30500(k,1);
   br30500_br33500(:,2:4)=br30500(k,2:4);
   br30500_br33500(:,5:7)=br33500(k,2:4);
   br30500_br33500(:,8)=dist30500(k,22);
end

k=find(dist30500(:,23)<=36);
if length(k)~=0;
   br30500_br33600(:,1)=dist30500(k,1);
   br30500_br33600(:,2:4)=br30500(k,2:4);
   br30500_br33600(:,5:7)=br33600(k,2:4);
   br30500_br33600(:,8)=dist30500(k,23);
end

k=find(dist30500(:,24)<=36);
if length(k)~=0;
   br30500_br33700(:,1)=dist30500(k,1);
   br30500_br33700(:,2:4)=br30500(k,2:4);
   br30500_br33700(:,5:7)=br33700(k,2:4);
   br30500_br33700(:,8)=dist30500(k,24);
end

k=find(dist30500(:,25)<=36);
if length(k)~=0;
   br30500_br33800(:,1)=dist30500(k,1);
   br30500_br33800(:,2:4)=br30500(k,2:4);
   br30500_br33800(:,5:7)=br33800(k,2:4);
   br30500_br33800(:,8)=dist30500(k,25);
end
```

```
k=find(dist30500(:,26)<=36);
if length(k)~=0;
   br30500_br34000(:,1)=dist30500(k,1);
   br30500_br34000(:,2:4)=br30500(k,2:4);
   br30500_br34000(:,5:7)=br34000(k,2:4);
   br30500_br34000(:,8)=dist30500(k,26);
end

k=find(dist30500(:,27)<=36);
if length(k)~=0;
   br30500_br34200(:,1)=dist30500(k,1);
   br30500_br34200(:,2:4)=br30500(k,2:4);
   br30500_br34200(:,5:7)=br34200(k,2:4);
   br30500_br34200(:,8)=dist30500(k,27);
end

k=find(dist30500(:,28)<=36);
if length(k)~=0;
   br30500_br34300(:,1)=dist30500(k,1);
   br30500_br34300(:,2:4)=br30500(k,2:4);
   br30500_br34300(:,5:7)=br34300(k,2:4);
   br30500_br34300(:,8)=dist30500(k,28);
end

k=find(dist30500(:,29)<=36);
if length(k)~=0;
   br30500_br34600(:,1)=dist30500(k,1);
   br30500_br34600(:,2:4)=br30500(k,2:4);
   br30500_br34600(:,5:7)=br34600(k,2:4);
   br30500_br34600(:,8)=dist30500(k,29);
end

k=find(dist30500(:,30)<=36);
if length(k)~=0;
   br30500_br34800(:,1)=dist30500(k,1);
   br30500_br34800(:,2:4)=br30500(k,2:4);
   br30500_br34800(:,5:7)=br34800(k,2:4);
   br30500_br34800(:,8)=dist30500(k,30);
end

k=find(dist30500(:,31)<=36);
if length(k)~=0;
   br30500_br34900(:,1)=dist30500(k,1);
   br30500_br34900(:,2:4)=br30500(k,2:4);
   br30500_br34900(:,5:7)=br34900(k,2:4);
   br30500_br34900(:,8)=dist30500(k,31);
end

k=find(dist30500(:,32)<=36);
if length(k)~=0;
```

```
        br30500_br35000(:,1)=dist30500(k,1);
        br30500_br35000(:,2:4)=br30500(k,2:4);
        br30500_br35000(:,5:7)=br35000(k,2:4);
        br30500_br35000(:,8)=dist30500(k,32);
    end
end

if isempty(dist30600);
else
    k=find(dist30600(:,6)<=36);
    if length(k)~=0;
        br30600_br30800(:,1)=dist30600(k,1);
        br30600_br30800(:,2:4)=br30600(k,2:4);
        br30600_br30800(:,5:7)=br30800(k,2:4);
        br30600_br30800(:,8)=dist30600(k,6);
    end

    k=find(dist30600(:,7)<=36);
    if length(k)~=0;
        br30600_br31200(:,1)=dist30600(k,1);
        br30600_br31200(:,2:4)=br30600(k,2:4);
        br30600_br31200(:,5:7)=br31200(k,2:4);
        br30600_br31200(:,8)=dist30600(k,7);
    end

    k=find(dist30600(:,8)<=36);
    if length(k)~=0;
        br30600_br31300(:,1)=dist30600(k,1);
        br30600_br31300(:,2:4)=br30600(k,2:4);
        br30600_br31300(:,5:7)=br31300(k,2:4);
        br30600_br31300(:,8)=dist30600(k,8);
    end

    k=find(dist30600(:,9)<=36);
    if length(k)~=0;
        br30600_br31400(:,1)=dist30600(k,1);
        br30600_br31400(:,2:4)=br30600(k,2:4);
        br30600_br31400(:,5:7)=br31400(k,2:4);
        br30600_br31400(:,8)=dist30600(k,9);
    end

    k=find(dist30600(:,10)<=36);
    if length(k)~=0;
        br30600_br31500(:,1)=dist30600(k,1);
        br30600_br31500(:,2:4)=br30600(k,2:4);
        br30600_br31500(:,5:7)=br31500(k,2:4);
        br30600_br31500(:,8)=dist30600(k,10);
    end

    k=find(dist30600(:,11)<=36);
```

```
if length(k)~=0;
   br30600_br31600(:,1)=dist30600(k,1);
   br30600_br31600(:,2:4)=br30600(k,2:4);
   br30600_br31600(:,5:7)=br31600(k,2:4);
   br30600_br31600(:,8)=dist30600(k,11);
end

k=find(dist30600(:,12)<=36);
if length(k)~=0;
   br30600_br31800(:,1)=dist30600(k,1);
   br30600_br31800(:,2:4)=br30600(k,2:4);
   br30600_br31800(:,5:7)=br31800(k,2:4);
   br30600_br31800(:,8)=dist30600(k,12);
end

k=find(dist30600(:,13)<=36);
if length(k)~=0;
   br30600_br32100(:,1)=dist30600(k,1);
   br30600_br32100(:,2:4)=br30600(k,2:4);
   br30600_br32100(:,5:7)=br32100(k,2:4);
   br30600_br32100(:,8)=dist30600(k,13);
end

k=find(dist30600(:,14)<=36);
if length(k)~=0;
   br30600_br32300(:,1)=dist30600(k,1);
   br30600_br32300(:,2:4)=br30600(k,2:4);
   br30600_br32300(:,5:7)=br32300(k,2:4);
   br30600_br32300(:,8)=dist30600(k,14);
end

k=find(dist30600(:,15)<=36);
if length(k)~=0;
   br30600_br32400(:,1)=dist30600(k,1);
   br30600_br32400(:,2:4)=br30600(k,2:4);
   br30600_br32400(:,5:7)=br32400(k,2:4);
   br30600_br32400(:,8)=dist30600(k,15);
end

k=find(dist30600(:,16)<=36);
if length(k)~=0;
   br30600_br32500(:,1)=dist30600(k,1);
   br30600_br32500(:,2:4)=br30600(k,2:4);
   br30600_br32500(:,5:7)=br32500(k,2:4);
   br30600_br32500(:,8)=dist30600(k,16);
end

k=find(dist30600(:,17)<=36);
if length(k)~=0;
   br30600_br32700(:,1)=dist30600(k,1);
```

```
    br30600_br32700(:,2:4)=br30600(k,2:4);
    br30600_br32700(:,5:7)=br32700(k,2:4);
    br30600_br32700(:,8)=dist30600(k,17);
end

k=find(dist30600(:,18)<=36);
if length(k)~=0;
    br30600_br32900(:,1)=dist30600(k,1);
    br30600_br32900(:,2:4)=br30600(k,2:4);
    br30600_br32900(:,5:7)=br32900(k,2:4);
    br30600_br32900(:,8)=dist30600(k,18);
end

k=find(dist30600(:,19)<=36);
if length(k)~=0;
    br30600_br33000(:,1)=dist30600(k,1);
    br30600_br33000(:,2:4)=br30600(k,2:4);
    br30600_br33000(:,5:7)=br33000(k,2:4);
    br30600_br33000(:,8)=dist30600(k,19);
end

k=find(dist30600(:,20)<=36);
if length(k)~=0;
    br30600_br33200(:,1)=dist30600(k,1);
    br30600_br33200(:,2:4)=br30600(k,2:4);
    br30600_br33200(:,5:7)=br33200(k,2:4);
    br30600_br33200(:,8)=dist30600(k,20);
end

k=find(dist30600(:,21)<=36);
if length(k)~=0;
    br30600_br33300(:,1)=dist30600(k,1);
    br30600_br33300(:,2:4)=br30600(k,2:4);
    br30600_br33300(:,5:7)=br33300(k,2:4);
    br30600_br33300(:,8)=dist30600(k,21);
end

k=find(dist30600(:,22)<=36);
if length(k)~=0;
    br30600_br33500(:,1)=dist30600(k,1);
    br30600_br33500(:,2:4)=br30600(k,2:4);
    br30600_br33500(:,5:7)=br33500(k,2:4);
    br30600_br33500(:,8)=dist30600(k,22);
end

k=find(dist30600(:,23)<=36);
if length(k)~=0;
    br30600_br33600(:,1)=dist30600(k,1);
    br30600_br33600(:,2:4)=br30600(k,2:4);
    br30600_br33600(:,5:7)=br33600(k,2:4);
```

```
    br30600_br33600(:,8)=dist30600(k,23);
end

k=find(dist30600(:,24)<=36);
if length(k)~=0;
    br30600_br33700(:,1)=dist30600(k,1);
    br30600_br33700(:,2:4)=br30600(k,2:4);
    br30600_br33700(:,5:7)=br33700(k,2:4);
    br30600_br33700(:,8)=dist30600(k,24);
end

k=find(dist30600(:,25)<=36);
if length(k)~=0;
    br30600_br33800(:,1)=dist30600(k,1);
    br30600_br33800(:,2:4)=br30600(k,2:4);
    br30600_br33800(:,5:7)=br33800(k,2:4);
    br30600_br33800(:,8)=dist30600(k,25);
end

k=find(dist30600(:,26)<=36);
if length(k)~=0;
    br30600_br34000(:,1)=dist30600(k,1);
    br30600_br34000(:,2:4)=br30600(k,2:4);
    br30600_br34000(:,5:7)=br34000(k,2:4);
    br30600_br34000(:,8)=dist30600(k,26);
end

k=find(dist30600(:,27)<=36);
if length(k)~=0;
    br30600_br34200(:,1)=dist30600(k,1);
    br30600_br34200(:,2:4)=br30600(k,2:4);
    br30600_br34200(:,5:7)=br34200(k,2:4);
    br30600_br34200(:,8)=dist30600(k,27);
end

k=find(dist30600(:,28)<=36);
if length(k)~=0;
    br30600_br34300(:,1)=dist30600(k,1);
    br30600_br34300(:,2:4)=br30600(k,2:4);
    br30600_br34300(:,5:7)=br34300(k,2:4);
    br30600_br34300(:,8)=dist30600(k,28);
end

k=find(dist30600(:,29)<=36);
if length(k)~=0;
    br30600_br34600(:,1)=dist30600(k,1);
    br30600_br34600(:,2:4)=br30600(k,2:4);
    br30600_br34600(:,5:7)=br34600(k,2:4);
    br30600_br34600(:,8)=dist30600(k,29);
end
```

```
    k=find(dist30600(:,30)<=36);
    if length(k)~=0;
        br30600_br34800(:,1)=dist30600(k,1);
        br30600_br34800(:,2:4)=br30600(k,2:4);
        br30600_br34800(:,5:7)=br34800(k,2:4);
        br30600_br34800(:,8)=dist30600(k,30);
    end

    k=find(dist30600(:,31)<=36);
    if length(k)~=0;
        br30600_br34900(:,1)=dist30600(k,1);
        br30600_br34900(:,2:4)=br30600(k,2:4);
        br30600_br34900(:,5:7)=br34900(k,2:4);
        br30600_br34900(:,8)=dist30600(k,31);
    end

    k=find(dist30600(:,32)<=36);
    if length(k)~=0;
        br30600_br35000(:,1)=dist30600(k,1);
        br30600_br35000(:,2:4)=br30600(k,2:4);
        br30600_br35000(:,5:7)=br35000(k,2:4);
        br30600_br35000(:,8)=dist30600(k,32);
    end
end

if isempty(dist30800);
else
    k=find(dist30800(:,7)<=36);
    if length(k)~=0;
        br30800_br31200(:,1)=dist30800(k,1);
        br30800_br31200(:,2:4)=br30800(k,2:4);
        br30800_br31200(:,5:7)=br31200(k,2:4);
        br30800_br31200(:,8)=dist30800(k,7);
    end

    k=find(dist30800(:,8)<=36);
    if length(k)~=0;
        br30800_br31300(:,1)=dist30800(k,1);
        br30800_br31300(:,2:4)=br30800(k,2:4);
        br30800_br31300(:,5:7)=br31300(k,2:4);
        br30800_br31300(:,8)=dist30800(k,8);
    end

    k=find(dist30800(:,9)<=36);
    if length(k)~=0;
        br30800_br31400(:,1)=dist30800(k,1);
        br30800_br31400(:,2:4)=br30800(k,2:4);
        br30800_br31400(:,5:7)=br31400(k,2:4);
        br30800_br31400(:,8)=dist30800(k,9);
```

```
end

k=find(dist30800(:,10)<=36);
if length(k)~=0;
   br30800_br31500(:,1)=dist30800(k,1);
   br30800_br31500(:,2:4)=br30800(k,2:4);
   br30800_br31500(:,5:7)=br31500(k,2:4);
   br30800_br31500(:,8)=dist30800(k,10);
end

k=find(dist30800(:,11)<=36);
if length(k)~=0;
   br30800_br31600(:,1)=dist30800(k,1);
   br30800_br31600(:,2:4)=br30800(k,2:4);
   br30800_br31600(:,5:7)=br31600(k,2:4);
   br30800_br31600(:,8)=dist30800(k,11);
end

k=find(dist30800(:,12)<=36);
if length(k)~=0;
   br30800_br31800(:,1)=dist30800(k,1);
   br30800_br31800(:,2:4)=br30800(k,2:4);
   br30800_br31800(:,5:7)=br31800(k,2:4);
   br30800_br31800(:,8)=dist30800(k,12);
end

k=find(dist30800(:,13)<=36);
if length(k)~=0;
   br30800_br32100(:,1)=dist30800(k,1);
   br30800_br32100(:,2:4)=br30800(k,2:4);
   br30800_br32100(:,5:7)=br32100(k,2:4);
   br30800_br32100(:,8)=dist30800(k,13);
end

k=find(dist30800(:,14)<=36);
if length(k)~=0;
   br30800_br32300(:,1)=dist30800(k,1);
   br30800_br32300(:,2:4)=br30800(k,2:4);
   br30800_br32300(:,5:7)=br32300(k,2:4);
   br30800_br32300(:,8)=dist30800(k,14);
end

k=find(dist30800(:,15)<=36);
if length(k)~=0;
   br30800_br32400(:,1)=dist30800(k,1);
   br30800_br32400(:,2:4)=br30800(k,2:4);
   br30800_br32400(:,5:7)=br32400(k,2:4);
   br30800_br32400(:,8)=dist30800(k,15);
end
```

```
k=find(dist30800(:,16)<=36);
if length(k)~=0;
   br30800_br32500(:,1)=dist30800(k,1);
   br30800_br32500(:,2:4)=br30800(k,2:4);
   br30800_br32500(:,5:7)=br32500(k,2:4);
   br30800_br32500(:,8)=dist30800(k,16);
end

k=find(dist30800(:,17)<=36);
if length(k)~=0;
   br30800_br32700(:,1)=dist30800(k,1);
   br30800_br32700(:,2:4)=br30800(k,2:4);
   br30800_br32700(:,5:7)=br32700(k,2:4);
   br30800_br32700(:,8)=dist30800(k,17);
end

k=find(dist30800(:,18)<=36);
if length(k)~=0;
   br30800_br32900(:,1)=dist30800(k,1);
   br30800_br32900(:,2:4)=br30800(k,2:4);
   br30800_br32900(:,5:7)=br32900(k,2:4);
   br30800_br32900(:,8)=dist30800(k,18);
end

k=find(dist30800(:,19)<=36);
if length(k)~=0;
   br30800_br33000(:,1)=dist30800(k,1);
   br30800_br33000(:,2:4)=br30800(k,2:4);
   br30800_br33000(:,5:7)=br33000(k,2:4);
   br30800_br33000(:,8)=dist30800(k,19);
end

k=find(dist30800(:,20)<=36);
if length(k)~=0;
   br30800_br33200(:,1)=dist30800(k,1);
   br30800_br33200(:,2:4)=br30800(k,2:4);
   br30800_br33200(:,5:7)=br33200(k,2:4);
   br30800_br33200(:,8)=dist30800(k,20);
end

k=find(dist30800(:,21)<=36);
if length(k)~=0;
   br30800_br33300(:,1)=dist30800(k,1);
   br30800_br33300(:,2:4)=br30800(k,2:4);
   br30800_br33300(:,5:7)=br33300(k,2:4);
   br30800_br33300(:,8)=dist30800(k,21);
end

k=find(dist30800(:,22)<=36);
if length(k)~=0;
```

```
    br30800_br33500(:,1)=dist30800(k,1);
    br30800_br33500(:,2:4)=br30800(k,2:4);
    br30800_br33500(:,5:7)=br33500(k,2:4);
    br30800_br33500(:,8)=dist30800(k,22);
end

k=find(dist30800(:,23)<=36);
if length(k)~=0;
    br30800_br33600(:,1)=dist30800(k,1);
    br30800_br33600(:,2:4)=br30800(k,2:4);
    br30800_br33600(:,5:7)=br33600(k,2:4);
    br30800_br33600(:,8)=dist30800(k,23);
end

k=find(dist30800(:,24)<=36);
if length(k)~=0;
    br30800_br33700(:,1)=dist30800(k,1);
    br30800_br33700(:,2:4)=br30800(k,2:4);
    br30800_br33700(:,5:7)=br33700(k,2:4);
    br30800_br33700(:,8)=dist30800(k,24);
end

k=find(dist30800(:,25)<=36);
if length(k)~=0;
    br30800_br33800(:,1)=dist30800(k,1);
    br30800_br33800(:,2:4)=br30800(k,2:4);
    br30800_br33800(:,5:7)=br33800(k,2:4);
    br30800_br33800(:,8)=dist30800(k,25);
end

k=find(dist30800(:,26)<=36);
if length(k)~=0;
    br30800_br34000(:,1)=dist30800(k,1);
    br30800_br34000(:,2:4)=br30800(k,2:4);
    br30800_br34000(:,5:7)=br34000(k,2:4);
    br30800_br34000(:,8)=dist30800(k,26);
end

k=find(dist30800(:,27)<=36);
if length(k)~=0;
    br30800_br34200(:,1)=dist30800(k,1);
    br30800_br34200(:,2:4)=br30800(k,2:4);
    br30800_br34200(:,5:7)=br34200(k,2:4);
    br30800_br34200(:,8)=dist30800(k,27);
end

k=find(dist30800(:,28)<=36);
if length(k)~=0;
    br30800_br34300(:,1)=dist30800(k,1);
    br30800_br34300(:,2:4)=br30800(k,2:4);
```

```
        br30800_br34300(:,5:7)=br34300(k,2:4);
        br30800_br34300(:,8)=dist30800(k,28);
    end

    k=find(dist30800(:,29)<=36);
    if length(k)~=0;
        br30800_br34600(:,1)=dist30800(k,1);
        br30800_br34600(:,2:4)=br30800(k,2:4);
        br30800_br34600(:,5:7)=br34600(k,2:4);
        br30800_br34600(:,8)=dist30800(k,29);
    end

    k=find(dist30800(:,30)<=36);
    if length(k)~=0;
        br30800_br34800(:,1)=dist30800(k,1);
        br30800_br34800(:,2:4)=br30800(k,2:4);
        br30800_br34800(:,5:7)=br34800(k,2:4);
        br30800_br34800(:,8)=dist30800(k,30);
    end

    k=find(dist30800(:,31)<=36);
    if length(k)~=0;
        br30800_br34900(:,1)=dist30800(k,1);
        br30800_br34900(:,2:4)=br30800(k,2:4);
        br30800_br34900(:,5:7)=br34900(k,2:4);
        br30800_br34900(:,8)=dist30800(k,31);
    end

    k=find(dist30800(:,32)<=36);
    if length(k)~=0;
        br30800_br35000(:,1)=dist30800(k,1);
        br30800_br35000(:,2:4)=br30800(k,2:4);
        br30800_br35000(:,5:7)=br35000(k,2:4);
        br30800_br35000(:,8)=dist30800(k,32);
    end
end

if isempty(dist31200);
else
    k=find(dist31200(:,8)<=36);
    if length(k)~=0;
        br31200_br31300(:,1)=dist31200(k,1);
        br31200_br31300(:,2:4)=br31200(k,2:4);
        br31200_br31300(:,5:7)=br31300(k,2:4);
        br31200_br31300(:,8)=dist31200(k,8);
    end

    k=find(dist31200(:,9)<=36);
    if length(k)~=0;
        br31200_br31400(:,1)=dist31200(k,1);
```

```
    br31200_br31400(:,2:4)=br31200(k,2:4);
    br31200_br31400(:,5:7)=br31400(k,2:4);
    br31200_br31400(:,8)=dist31200(k,9);
end

k=find(dist31200(:,10)<=36);
if length(k)~=0;
    br31200_br31500(:,1)=dist31200(k,1);
    br31200_br31500(:,2:4)=br31200(k,2:4);
    br31200_br31500(:,5:7)=br31500(k,2:4);
    br31200_br31500(:,8)=dist31200(k,10);
end

k=find(dist31200(:,11)<=36);
if length(k)~=0;
    br31200_br31600(:,1)=dist31200(k,1);
    br31200_br31600(:,2:4)=br31200(k,2:4);
    br31200_br31600(:,5:7)=br31600(k,2:4);
    br31200_br31600(:,8)=dist31200(k,11);
end

k=find(dist31200(:,12)<=36);
if length(k)~=0;
    br31200_br31800(:,1)=dist31200(k,1);
    br31200_br31800(:,2:4)=br31200(k,2:4);
    br31200_br31800(:,5:7)=br31800(k,2:4);
    br31200_br31800(:,8)=dist31200(k,12);
end

k=find(dist31200(:,13)<=36);
if length(k)~=0;
    br31200_br32100(:,1)=dist31200(k,1);
    br31200_br32100(:,2:4)=br31200(k,2:4);
    br31200_br32100(:,5:7)=br32100(k,2:4);
    br31200_br32100(:,8)=dist31200(k,13);
end

k=find(dist31200(:,14)<=36);
if length(k)~=0;
    br31200_br32300(:,1)=dist31200(k,1);
    br31200_br32300(:,2:4)=br31200(k,2:4);
    br31200_br32300(:,5:7)=br32300(k,2:4);
    br31200_br32300(:,8)=dist31200(k,14);
end

k=find(dist31200(:,15)<=36);
if length(k)~=0;
    br31200_br32400(:,1)=dist31200(k,1);
    br31200_br32400(:,2:4)=br31200(k,2:4);
    br31200_br32400(:,5:7)=br32400(k,2:4);
```

```
    br31200_br32400(:,8)=dist31200(k,15);
end

k=find(dist31200(:,16)<=36);
if length(k)~=0;
    br31200_br32500(:,1)=dist31200(k,1);
    br31200_br32500(:,2:4)=br31200(k,2:4);
    br31200_br32500(:,5:7)=br32500(k,2:4);
    br31200_br32500(:,8)=dist31200(k,16);
end

k=find(dist31200(:,17)<=36);
if length(k)~=0;
    br31200_br32700(:,1)=dist31200(k,1);
    br31200_br32700(:,2:4)=br31200(k,2:4);
    br31200_br32700(:,5:7)=br32700(k,2:4);
    br31200_br32700(:,8)=dist31200(k,17);
end

k=find(dist31200(:,18)<=36);
if length(k)~=0;
    br31200_br32900(:,1)=dist31200(k,1);
    br31200_br32900(:,2:4)=br31200(k,2:4);
    br31200_br32900(:,5:7)=br32900(k,2:4);
    br31200_br32900(:,8)=dist31200(k,18);
end

k=find(dist31200(:,19)<=36);
if length(k)~=0;
    br31200_br33000(:,1)=dist31200(k,1);
    br31200_br33000(:,2:4)=br31200(k,2:4);
    br31200_br33000(:,5:7)=br33000(k,2:4);
    br31200_br33000(:,8)=dist31200(k,19);
end

k=find(dist31200(:,20)<=36);
if length(k)~=0;
    br31200_br33200(:,1)=dist31200(k,1);
    br31200_br33200(:,2:4)=br31200(k,2:4);
    br31200_br33200(:,5:7)=br33200(k,2:4);
    br31200_br33200(:,8)=dist31200(k,20);
end

k=find(dist31200(:,21)<=36);
if length(k)~=0;
    br31200_br33300(:,1)=dist31200(k,1);
    br31200_br33300(:,2:4)=br31200(k,2:4);
    br31200_br33300(:,5:7)=br33300(k,2:4);
    br31200_br33300(:,8)=dist31200(k,21);
end
```

```
k=find(dist31200(:,22)<=36);
if length(k)~=0;
   br31200_br33500(:,1)=dist31200(k,1);
   br31200_br33500(:,2:4)=br31200(k,2:4);
   br31200_br33500(:,5:7)=br33500(k,2:4);
   br31200_br33500(:,8)=dist31200(k,22);
end

k=find(dist31200(:,23)<=36);
if length(k)~=0;
   br31200_br33600(:,1)=dist31200(k,1);
   br31200_br33600(:,2:4)=br31200(k,2:4);
   br31200_br33600(:,5:7)=br33600(k,2:4);
   br31200_br33600(:,8)=dist31200(k,23);
end

k=find(dist31200(:,24)<=36);
if length(k)~=0;
   br31200_br33700(:,1)=dist31200(k,1);
   br31200_br33700(:,2:4)=br31200(k,2:4);
   br31200_br33700(:,5:7)=br33700(k,2:4);
   br31200_br33700(:,8)=dist31200(k,24);
end

k=find(dist31200(:,25)<=36);
if length(k)~=0;
   br31200_br33800(:,1)=dist31200(k,1);
   br31200_br33800(:,2:4)=br31200(k,2:4);
   br31200_br33800(:,5:7)=br33800(k,2:4);
   br31200_br33800(:,8)=dist31200(k,25);
end

k=find(dist31200(:,26)<=36);
if length(k)~=0;
   br31200_br34000(:,1)=dist31200(k,1);
   br31200_br34000(:,2:4)=br31200(k,2:4);
   br31200_br34000(:,5:7)=br34000(k,2:4);
   br31200_br34000(:,8)=dist31200(k,26);
end

k=find(dist31200(:,27)<=36);
if length(k)~=0;
   br31200_br34200(:,1)=dist31200(k,1);
   br31200_br34200(:,2:4)=br31200(k,2:4);
   br31200_br34200(:,5:7)=br34200(k,2:4);
   br31200_br34200(:,8)=dist31200(k,27);
end

k=find(dist31200(:,28)<=36);
```

```
    if length(k)~=0;
        br31200_br34300(:,1)=dist31200(k,1);
        br31200_br34300(:,2:4)=br31200(k,2:4);
        br31200_br34300(:,5:7)=br34300(k,2:4);
        br31200_br34300(:,8)=dist31200(k,28);
    end

    k=find(dist31200(:,29)<=36);
    if length(k)~=0;
        br31200_br34600(:,1)=dist31200(k,1);
        br31200_br34600(:,2:4)=br31200(k,2:4);
        br31200_br34600(:,5:7)=br34600(k,2:4);
        br31200_br34600(:,8)=dist31200(k,29);
    end

    k=find(dist31200(:,30)<=36);
    if length(k)~=0;
        br31200_br34800(:,1)=dist31200(k,1);
        br31200_br34800(:,2:4)=br31200(k,2:4);
        br31200_br34800(:,5:7)=br34800(k,2:4);
        br31200_br34800(:,8)=dist31200(k,30);
    end

    k=find(dist31200(:,31)<=36);
    if length(k)~=0;
        br31200_br34900(:,1)=dist31200(k,1);
        br31200_br34900(:,2:4)=br31200(k,2:4);
        br31200_br34900(:,5:7)=br34900(k,2:4);
        br31200_br34900(:,8)=dist31200(k,31);
    end

    k=find(dist31200(:,32)<=36);
    if length(k)~=0;
        br31200_br35000(:,1)=dist31200(k,1);
        br31200_br35000(:,2:4)=br31200(k,2:4);
        br31200_br35000(:,5:7)=br35000(k,2:4);
        br31200_br35000(:,8)=dist31200(k,32);
    end
end

if isempty(dist31300);
else
    k=find(dist31300(:,9)<=36);
    if length(k)~=0;
        br31300_br31400(:,1)=dist31300(k,1);
        br31300_br31400(:,2:4)=br31300(k,2:4);
        br31300_br31400(:,5:7)=br31400(k,2:4);
        br31300_br31400(:,8)=dist31300(k,9);
    end
```

```
k=find(dist31300(:,10)<=36);
if length(k)~=0;
   br31300_br31500(:,1)=dist31300(k,1);
   br31300_br31500(:,2:4)=br31300(k,2:4);
   br31300_br31500(:,5:7)=br31500(k,2:4);
   br31300_br31500(:,8)=dist31300(k,10);
end

k=find(dist31300(:,11)<=36);
if length(k)~=0;
   br31300_br31600(:,1)=dist31300(k,1);
   br31300_br31600(:,2:4)=br31300(k,2:4);
   br31300_br31600(:,5:7)=br31600(k,2:4);
   br31300_br31600(:,8)=dist31300(k,11);
end

k=find(dist31300(:,12)<=36);
if length(k)~=0;
   br31300_br31800(:,1)=dist31300(k,1);
   br31300_br31800(:,2:4)=br31300(k,2:4);
   br31300_br31800(:,5:7)=br31800(k,2:4);
   br31300_br31800(:,8)=dist31300(k,12);
end

k=find(dist31300(:,13)<=36);
if length(k)~=0;
   br31300_br32100(:,1)=dist31300(k,1);
   br31300_br32100(:,2:4)=br31300(k,2:4);
   br31300_br32100(:,5:7)=br32100(k,2:4);
   br31300_br32100(:,8)=dist31300(k,13);
end

k=find(dist31300(:,14)<=36);
if length(k)~=0;
   br31300_br32300(:,1)=dist31300(k,1);
   br31300_br32300(:,2:4)=br31300(k,2:4);
   br31300_br32300(:,5:7)=br32300(k,2:4);
   br31300_br32300(:,8)=dist31300(k,14);
end

k=find(dist31300(:,15)<=36);
if length(k)~=0;
   br31300_br32400(:,1)=dist31300(k,1);
   br31300_br32400(:,2:4)=br31300(k,2:4);
   br31300_br32400(:,5:7)=br32400(k,2:4);
   br31300_br32400(:,8)=dist31300(k,15);
end

k=find(dist31300(:,16)<=36);
if length(k)~=0;
```

```
    br31300_br32500(:,1)=dist31300(k,1);
    br31300_br32500(:,2:4)=br31300(k,2:4);
    br31300_br32500(:,5:7)=br32500(k,2:4);
    br31300_br32500(:,8)=dist31300(k,16);
end

k=find(dist31300(:,17)<=36);
if length(k)~=0;
    br31300_br32700(:,1)=dist31300(k,1);
    br31300_br32700(:,2:4)=br31300(k,2:4);
    br31300_br32700(:,5:7)=br32700(k,2:4);
    br31300_br32700(:,8)=dist31300(k,17);
end

k=find(dist31300(:,18)<=36);
if length(k)~=0;
    br31300_br32900(:,1)=dist31300(k,1);
    br31300_br32900(:,2:4)=br31300(k,2:4);
    br31300_br32900(:,5:7)=br32900(k,2:4);
    br31300_br32900(:,8)=dist31300(k,18);
end

k=find(dist31300(:,19)<=36);
if length(k)~=0;
    br31300_br33000(:,1)=dist31300(k,1);
    br31300_br33000(:,2:4)=br31300(k,2:4);
    br31300_br33000(:,5:7)=br33000(k,2:4);
    br31300_br33000(:,8)=dist31300(k,19);
end

k=find(dist31300(:,20)<=36);
if length(k)~=0;
    br31300_br33200(:,1)=dist31300(k,1);
    br31300_br33200(:,2:4)=br31300(k,2:4);
    br31300_br33200(:,5:7)=br33200(k,2:4);
    br31300_br33200(:,8)=dist31300(k,20);
end

k=find(dist31300(:,21)<=36);
if length(k)~=0;
    br31300_br33300(:,1)=dist31300(k,1);
    br31300_br33300(:,2:4)=br31300(k,2:4);
    br31300_br33300(:,5:7)=br33300(k,2:4);
    br31300_br33300(:,8)=dist31300(k,21);
end

k=find(dist31300(:,22)<=36);
if length(k)~=0;
    br31300_br33500(:,1)=dist31300(k,1);
    br31300_br33500(:,2:4)=br31300(k,2:4);
```

```
    br31300_br33500(:,5:7)=br33500(k,2:4);
    br31300_br33500(:,8)=dist31300(k,22);
end

k=find(dist31300(:,23)<=36);
if length(k)~=0;
    br31300_br33600(:,1)=dist31300(k,1);
    br31300_br33600(:,2:4)=br31300(k,2:4);
    br31300_br33600(:,5:7)=br33600(k,2:4);
    br31300_br33600(:,8)=dist31300(k,23);
end

k=find(dist31300(:,24)<=36);
if length(k)~=0;
    br31300_br33700(:,1)=dist31300(k,1);
    br31300_br33700(:,2:4)=br31300(k,2:4);
    br31300_br33700(:,5:7)=br33700(k,2:4);
    br31300_br33700(:,8)=dist31300(k,24);
end

k=find(dist31300(:,25)<=36);
if length(k)~=0;
    br31300_br33800(:,1)=dist31300(k,1);
    br31300_br33800(:,2:4)=br31300(k,2:4);
    br31300_br33800(:,5:7)=br33800(k,2:4);
    br31300_br33800(:,8)=dist31300(k,25);
end

k=find(dist31300(:,26)<=36);
if length(k)~=0;
    br31300_br34000(:,1)=dist31300(k,1);
    br31300_br34000(:,2:4)=br31300(k,2:4);
    br31300_br34000(:,5:7)=br34000(k,2:4);
    br31300_br34000(:,8)=dist31300(k,26);
end

k=find(dist31300(:,27)<=36);
if length(k)~=0;
    br31300_br34200(:,1)=dist31300(k,1);
    br31300_br34200(:,2:4)=br31300(k,2:4);
    br31300_br34200(:,5:7)=br34200(k,2:4);
    br31300_br34200(:,8)=dist31300(k,27);
end

k=find(dist31300(:,28)<=36);
if length(k)~=0;
    br31300_br34300(:,1)=dist31300(k,1);
    br31300_br34300(:,2:4)=br31300(k,2:4);
    br31300_br34300(:,5:7)=br34300(k,2:4);
    br31300_br34300(:,8)=dist31300(k,28);
```

```
    end

    k=find(dist31300(:,29)<=36);
    if length(k)~=0;
        br31300_br34600(:,1)=dist31300(k,1);
        br31300_br34600(:,2:4)=br31300(k,2:4);
        br31300_br34600(:,5:7)=br34600(k,2:4);
        br31300_br34600(:,8)=dist31300(k,29);
    end

    k=find(dist31300(:,30)<=36);
    if length(k)~=0;
        br31300_br34800(:,1)=dist31300(k,1);
        br31300_br34800(:,2:4)=br31300(k,2:4);
        br31300_br34800(:,5:7)=br34800(k,2:4);
        br31300_br34800(:,8)=dist31300(k,30);
    end

    k=find(dist31300(:,31)<=36);
    if length(k)~=0;
        br31300_br34900(:,1)=dist31300(k,1);
        br31300_br34900(:,2:4)=br31300(k,2:4);
        br31300_br34900(:,5:7)=br34900(k,2:4);
        br31300_br34900(:,8)=dist31300(k,31);
    end

    k=find(dist31300(:,32)<=36);
    if length(k)~=0;
        br31300_br35000(:,1)=dist31300(k,1);
        br31300_br35000(:,2:4)=br31300(k,2:4);
        br31300_br35000(:,5:7)=br35000(k,2:4);
        br31300_br35000(:,8)=dist31300(k,32);
    end
end

if isempty(dist31400);
else
    k=find(dist31400(:,10)<=36);
    if length(k)~=0;
        br31400_br31500(:,1)=dist31400(k,1);
        br31400_br31500(:,2:4)=br31400(k,2:4);
        br31400_br31500(:,5:7)=br31500(k,2:4);
        br31400_br31500(:,8)=dist31400(k,10);
    end

    k=find(dist31400(:,11)<=36);
    if length(k)~=0;
        br31400_br31600(:,1)=dist31400(k,1);
        br31400_br31600(:,2:4)=br31400(k,2:4);
        br31400_br31600(:,5:7)=br31600(k,2:4);
```

```
    br31400_br31600(:,8)=dist31400(k,11);
end

k=find(dist31400(:,12)<=36);
if length(k)~=0;
    br31400_br31800(:,1)=dist31400(k,1);
    br31400_br31800(:,2:4)=br31400(k,2:4);
    br31400_br31800(:,5:7)=br31800(k,2:4);
    br31400_br31800(:,8)=dist31400(k,12);
end

k=find(dist31400(:,13)<=36);
if length(k)~=0;
    br31400_br32100(:,1)=dist31400(k,1);
    br31400_br32100(:,2:4)=br31400(k,2:4);
    br31400_br32100(:,5:7)=br32100(k,2:4);
    br31400_br32100(:,8)=dist31400(k,13);
end

k=find(dist31400(:,14)<=36);
if length(k)~=0;
    br31400_br32300(:,1)=dist31400(k,1);
    br31400_br32300(:,2:4)=br31400(k,2:4);
    br31400_br32300(:,5:7)=br32300(k,2:4);
    br31400_br32300(:,8)=dist31400(k,14);
end

k=find(dist31400(:,15)<=36);
if length(k)~=0;
    br31400_br32400(:,1)=dist31400(k,1);
    br31400_br32400(:,2:4)=br31400(k,2:4);
    br31400_br32400(:,5:7)=br32400(k,2:4);
    br31400_br32400(:,8)=dist31400(k,15);
end

k=find(dist31400(:,16)<=36);
if length(k)~=0;
    br31400_br32500(:,1)=dist31400(k,1);
    br31400_br32500(:,2:4)=br31400(k,2:4);
    br31400_br32500(:,5:7)=br32500(k,2:4);
    br31400_br32500(:,8)=dist31400(k,16);
end

k=find(dist31400(:,17)<=36);
if length(k)~=0;
    br31400_br32700(:,1)=dist31400(k,1);
    br31400_br32700(:,2:4)=br31400(k,2:4);
    br31400_br32700(:,5:7)=br32700(k,2:4);
    br31400_br32700(:,8)=dist31400(k,17);
end
```

```
k=find(dist31400(:,18)<=36);
if length(k)~=0;
   br31400_br32900(:,1)=dist31400(k,1);
   br31400_br32900(:,2:4)=br31400(k,2:4);
   br31400_br32900(:,5:7)=br32900(k,2:4);
   br31400_br32900(:,8)=dist31400(k,18);
end

k=find(dist31400(:,19)<=36);
if length(k)~=0;
   br31400_br33000(:,1)=dist31400(k,1);
   br31400_br33000(:,2:4)=br31400(k,2:4);
   br31400_br33000(:,5:7)=br33000(k,2:4);
   br31400_br33000(:,8)=dist31400(k,19);
end

k=find(dist31400(:,20)<=36);
if length(k)~=0;
   br31400_br33200(:,1)=dist31400(k,1);
   br31400_br33200(:,2:4)=br31400(k,2:4);
   br31400_br33200(:,5:7)=br33200(k,2:4);
   br31400_br33200(:,8)=dist31400(k,20);
end

k=find(dist31400(:,21)<=36);
if length(k)~=0;
   br31400_br33300(:,1)=dist31400(k,1);
   br31400_br33300(:,2:4)=br31400(k,2:4);
   br31400_br33300(:,5:7)=br33300(k,2:4);
   br31400_br33300(:,8)=dist31400(k,21);
end

k=find(dist31400(:,22)<=36);
if length(k)~=0;
   br31400_br33500(:,1)=dist31400(k,1);
   br31400_br33500(:,2:4)=br31400(k,2:4);
   br31400_br33500(:,5:7)=br33500(k,2:4);
   br31400_br33500(:,8)=dist31400(k,22);
end

k=find(dist31400(:,23)<=36);
if length(k)~=0;
   br31400_br33600(:,1)=dist31400(k,1);
   br31400_br33600(:,2:4)=br31400(k,2:4);
   br31400_br33600(:,5:7)=br33600(k,2:4);
   br31400_br33600(:,8)=dist31400(k,23);
end

k=find(dist31400(:,24)<=36);
```

```
if length(k)~=0;
   br31400_br33700(:,1)=dist31400(k,1);
   br31400_br33700(:,2:4)=br31400(k,2:4);
   br31400_br33700(:,5:7)=br33700(k,2:4);
   br31400_br33700(:,8)=dist31400(k,24);
end

k=find(dist31400(:,25)<=36);
if length(k)~=0;
   br31400_br33800(:,1)=dist31400(k,1);
   br31400_br33800(:,2:4)=br31400(k,2:4);
   br31400_br33800(:,5:7)=br33800(k,2:4);
   br31400_br33800(:,8)=dist31400(k,25);
end

k=find(dist31400(:,26)<=36);
if length(k)~=0;
   br31400_br34000(:,1)=dist31400(k,1);
   br31400_br34000(:,2:4)=br31400(k,2:4);
   br31400_br34000(:,5:7)=br34000(k,2:4);
   br31400_br34000(:,8)=dist31400(k,26);
end

k=find(dist31400(:,27)<=36);
if length(k)~=0;
   br31400_br34200(:,1)=dist31400(k,1);
   br31400_br34200(:,2:4)=br31400(k,2:4);
   br31400_br34200(:,5:7)=br34200(k,2:4);
   br31400_br34200(:,8)=dist31400(k,27);
end

k=find(dist31400(:,28)<=36);
if length(k)~=0;
   br31400_br34300(:,1)=dist31400(k,1);
   br31400_br34300(:,2:4)=br31400(k,2:4);
   br31400_br34300(:,5:7)=br34300(k,2:4);
   br31400_br34300(:,8)=dist31400(k,28);
end

k=find(dist31400(:,29)<=36);
if length(k)~=0;
   br31400_br34600(:,1)=dist31400(k,1);
   br31400_br34600(:,2:4)=br31400(k,2:4);
   br31400_br34600(:,5:7)=br34600(k,2:4);
   br31400_br34600(:,8)=dist31400(k,29);
end

k=find(dist31400(:,30)<=36);
if length(k)~=0;
   br31400_br34800(:,1)=dist31400(k,1);
```

```
        br31400_br34800(:,2:4)=br31400(k,2:4);
        br31400_br34800(:,5:7)=br34800(k,2:4);
        br31400_br34800(:,8)=dist31400(k,30);
    end

    k=find(dist31400(:,31)<=36);
    if length(k)~=0;
        br31400_br34900(:,1)=dist31400(k,1);
        br31400_br34900(:,2:4)=br31400(k,2:4);
        br31400_br34900(:,5:7)=br34900(k,2:4);
        br31400_br34900(:,8)=dist31400(k,31);
    end

    k=find(dist31400(:,32)<=36);
    if length(k)~=0;
        br31400_br35000(:,1)=dist31400(k,1);
        br31400_br35000(:,2:4)=br31400(k,2:4);
        br31400_br35000(:,5:7)=br35000(k,2:4);
        br31400_br35000(:,8)=dist31400(k,32);
    end
end

if isempty(dist31500);
else
    k=find(dist31500(:,11)<=36);
    if length(k)~=0;
        br31500_br31600(:,1)=dist31500(k,1);
        br31500_br31600(:,2:4)=br31500(k,2:4);
        br31500_br31600(:,5:7)=br31600(k,2:4);
        br31500_br31600(:,8)=dist31500(k,11);
    end

    k=find(dist31500(:,12)<=36);
    if length(k)~=0;
        br31500_br31800(:,1)=dist31500(k,1);
        br31500_br31800(:,2:4)=br31500(k,2:4);
        br31500_br31800(:,5:7)=br31800(k,2:4);
        br31500_br31800(:,8)=dist31500(k,12);
    end

    k=find(dist31500(:,13)<=36);
    if length(k)~=0;
        br31500_br32100(:,1)=dist31500(k,1);
        br31500_br32100(:,2:4)=br31500(k,2:4);
        br31500_br32100(:,5:7)=br32100(k,2:4);
        br31500_br32100(:,8)=dist31500(k,13);
    end

    k=find(dist31500(:,14)<=36);
    if length(k)~=0;
```

```
    br31500_br32300(:,1)=dist31500(k,1);
    br31500_br32300(:,2:4)=br31500(k,2:4);
    br31500_br32300(:,5:7)=br32300(k,2:4);
    br31500_br32300(:,8)=dist31500(k,14);
end

k=find(dist31500(:,15)<=36);
if length(k)~=0;
    br31500_br32400(:,1)=dist31500(k,1);
    br31500_br32400(:,2:4)=br31500(k,2:4);
    br31500_br32400(:,5:7)=br32400(k,2:4);
    br31500_br32400(:,8)=dist31500(k,15);
end

k=find(dist31500(:,16)<=36);
if length(k)~=0;
    br31500_br32500(:,1)=dist31500(k,1);
    br31500_br32500(:,2:4)=br31500(k,2:4);
    br31500_br32500(:,5:7)=br32500(k,2:4);
    br31500_br32500(:,8)=dist31500(k,16);
end

k=find(dist31500(:,17)<=36);
if length(k)~=0;
    br31500_br32700(:,1)=dist31500(k,1);
    br31500_br32700(:,2:4)=br31500(k,2:4);
    br31500_br32700(:,5:7)=br32700(k,2:4);
    br31500_br32700(:,8)=dist31500(k,17);
end

k=find(dist31500(:,18)<=36);
if length(k)~=0;
    br31500_br32900(:,1)=dist31500(k,1);
    br31500_br32900(:,2:4)=br31500(k,2:4);
    br31500_br32900(:,5:7)=br32900(k,2:4);
    br31500_br32900(:,8)=dist31500(k,18);
end

k=find(dist31500(:,19)<=36);
if length(k)~=0;
    br31500_br33000(:,1)=dist31500(k,1);
    br31500_br33000(:,2:4)=br31500(k,2:4);
    br31500_br33000(:,5:7)=br33000(k,2:4);
    br31500_br33000(:,8)=dist31500(k,19);
end

k=find(dist31500(:,20)<=36);
if length(k)~=0;
    br31500_br33200(:,1)=dist31500(k,1);
    br31500_br33200(:,2:4)=br31500(k,2:4);
```

```
    br31500_br33200(:,5:7)=br33200(k,2:4);
    br31500_br33200(:,8)=dist31500(k,20);
end

k=find(dist31500(:,21)<=36);
if length(k)~=0;
    br31500_br33300(:,1)=dist31500(k,1);
    br31500_br33300(:,2:4)=br31500(k,2:4);
    br31500_br33300(:,5:7)=br33300(k,2:4);
    br31500_br33300(:,8)=dist31500(k,21);
end

k=find(dist31500(:,22)<=36);
if length(k)~=0;
    br31500_br33500(:,1)=dist31500(k,1);
    br31500_br33500(:,2:4)=br31500(k,2:4);
    br31500_br33500(:,5:7)=br33500(k,2:4);
    br31500_br33500(:,8)=dist31500(k,22);
end

k=find(dist31500(:,23)<=36);
if length(k)~=0;
    br31500_br33600(:,1)=dist31500(k,1);
    br31500_br33600(:,2:4)=br31500(k,2:4);
    br31500_br33600(:,5:7)=br33600(k,2:4);
    br31500_br33600(:,8)=dist31500(k,23);
end

k=find(dist31500(:,24)<=36);
if length(k)~=0;
    br31500_br33700(:,1)=dist31500(k,1);
    br31500_br33700(:,2:4)=br31500(k,2:4);
    br31500_br33700(:,5:7)=br33700(k,2:4);
    br31500_br33700(:,8)=dist31500(k,24);
end

k=find(dist31500(:,25)<=36);
if length(k)~=0;
    br31500_br33800(:,1)=dist31500(k,1);
    br31500_br33800(:,2:4)=br31500(k,2:4);
    br31500_br33800(:,5:7)=br33800(k,2:4);
    br31500_br33800(:,8)=dist31500(k,25);
end

k=find(dist31500(:,26)<=36);
if length(k)~=0;
    br31500_br34000(:,1)=dist31500(k,1);
    br31500_br34000(:,2:4)=br31500(k,2:4);
    br31500_br34000(:,5:7)=br34000(k,2:4);
    br31500_br34000(:,8)=dist31500(k,26);
```

```
    end

    k=find(dist31500(:,27)<=36);
    if length(k)~=0;
       br31500_br34200(:,1)=dist31500(k,1);
       br31500_br34200(:,2:4)=br31500(k,2:4);
       br31500_br34200(:,5:7)=br34200(k,2:4);
       br31500_br34200(:,8)=dist31500(k,27);
    end

    k=find(dist31500(:,28)<=36);
    if length(k)~=0;
       br31500_br34300(:,1)=dist31500(k,1);
       br31500_br34300(:,2:4)=br31500(k,2:4);
       br31500_br34300(:,5:7)=br34300(k,2:4);
       br31500_br34300(:,8)=dist31500(k,28);
    end

    k=find(dist31500(:,29)<=36);
    if length(k)~=0;
       br31500_br34600(:,1)=dist31500(k,1);
       br31500_br34600(:,2:4)=br31500(k,2:4);
       br31500_br34600(:,5:7)=br34600(k,2:4);
       br31500_br34600(:,8)=dist31500(k,29);
    end

    k=find(dist31500(:,30)<=36);
    if length(k)~=0;
       br31500_br34800(:,1)=dist31500(k,1);
       br31500_br34800(:,2:4)=br31500(k,2:4);
       br31500_br34800(:,5:7)=br34800(k,2:4);
       br31500_br34800(:,8)=dist31500(k,30);
    end

    k=find(dist31500(:,31)<=36);
    if length(k)~=0;
       br31500_br34900(:,1)=dist31500(k,1);
       br31500_br34900(:,2:4)=br31500(k,2:4);
       br31500_br34900(:,5:7)=br34900(k,2:4);
       br31500_br34900(:,8)=dist31500(k,31);
    end

    k=find(dist31500(:,32)<=36);
    if length(k)~=0;
       br31500_br35000(:,1)=dist31500(k,1);
       br31500_br35000(:,2:4)=br31500(k,2:4);
       br31500_br35000(:,5:7)=br35000(k,2:4);
       br31500_br35000(:,8)=dist31500(k,32);
    end
end
```

```
if isempty(dist31600);
else
    k=find(dist31600(:,12)<=36);
    if length(k)~=0;
        br31600_br31800(:,1)=dist31600(k,1);
        br31600_br31800(:,2:4)=br31600(k,2:4);
        br31600_br31800(:,5:7)=br31800(k,2:4);
        br31600_br31800(:,8)=dist31600(k,12);
    end

    k=find(dist31600(:,13)<=36);
    if length(k)~=0;
        br31600_br32100(:,1)=dist31600(k,1);
        br31600_br32100(:,2:4)=br31600(k,2:4);
        br31600_br32100(:,5:7)=br32100(k,2:4);
        br31600_br32100(:,8)=dist31600(k,13);
    end

    k=find(dist31600(:,14)<=36);
    if length(k)~=0;
        br31600_br32300(:,1)=dist31600(k,1);
        br31600_br32300(:,2:4)=br31600(k,2:4);
        br31600_br32300(:,5:7)=br32300(k,2:4);
        br31600_br32300(:,8)=dist31600(k,14);
    end

    k=find(dist31600(:,15)<=36);
    if length(k)~=0;
        br31600_br32400(:,1)=dist31600(k,1);
        br31600_br32400(:,2:4)=br31600(k,2:4);
        br31600_br32400(:,5:7)=br32400(k,2:4);
        br31600_br32400(:,8)=dist31600(k,15);
    end

    k=find(dist31600(:,16)<=36);
    if length(k)~=0;
        br31600_br32500(:,1)=dist31600(k,1);
        br31600_br32500(:,2:4)=br31600(k,2:4);
        br31600_br32500(:,5:7)=br32500(k,2:4);
        br31600_br32500(:,8)=dist31600(k,16);
    end

    k=find(dist31600(:,17)<=36);
    if length(k)~=0;
        br31600_br32700(:,1)=dist31600(k,1);
        br31600_br32700(:,2:4)=br31600(k,2:4);
        br31600_br32700(:,5:7)=br32700(k,2:4);
        br31600_br32700(:,8)=dist31600(k,17);
    end
```

```
k=find(dist31600(:,18)<=36);
if length(k)~=0;
   br31600_br32900(:,1)=dist31600(k,1);
   br31600_br32900(:,2:4)=br31600(k,2:4);
   br31600_br32900(:,5:7)=br32900(k,2:4);
   br31600_br32900(:,8)=dist31600(k,18);
end

k=find(dist31600(:,19)<=36);
if length(k)~=0;
   br31600_br33000(:,1)=dist31600(k,1);
   br31600_br33000(:,2:4)=br31600(k,2:4);
   br31600_br33000(:,5:7)=br33000(k,2:4);
   br31600_br33000(:,8)=dist31600(k,19);
end

k=find(dist31600(:,20)<=36);
if length(k)~=0;
   br31600_br33200(:,1)=dist31600(k,1);
   br31600_br33200(:,2:4)=br31600(k,2:4);
   br31600_br33200(:,5:7)=br33200(k,2:4);
   br31600_br33200(:,8)=dist31600(k,20);
end

k=find(dist31600(:,21)<=36);
if length(k)~=0;
   br31600_br33300(:,1)=dist31600(k,1);
   br31600_br33300(:,2:4)=br31600(k,2:4);
   br31600_br33300(:,5:7)=br33300(k,2:4);
   br31600_br33300(:,8)=dist31600(k,21);
end

k=find(dist31600(:,22)<=36);
if length(k)~=0;
   br31600_br33500(:,1)=dist31600(k,1);
   br31600_br33500(:,2:4)=br31600(k,2:4);
   br31600_br33500(:,5:7)=br33500(k,2:4);
   br31600_br33500(:,8)=dist31600(k,22);
end

k=find(dist31600(:,23)<=36);
if length(k)~=0;
   br31600_br33600(:,1)=dist31600(k,1);
   br31600_br33600(:,2:4)=br31600(k,2:4);
   br31600_br33600(:,5:7)=br33600(k,2:4);
   br31600_br33600(:,8)=dist31600(k,23);
end

k=find(dist31600(:,24)<=36);
```

```
if length(k)~=0;
   br31600_br33700(:,1)=dist31600(k,1);
   br31600_br33700(:,2:4)=br31600(k,2:4);
   br31600_br33700(:,5:7)=br33700(k,2:4);
   br31600_br33700(:,8)=dist31600(k,24);
end

k=find(dist31600(:,25)<=36);
if length(k)~=0;
   br31600_br33800(:,1)=dist31600(k,1);
   br31600_br33800(:,2:4)=br31600(k,2:4);
   br31600_br33800(:,5:7)=br33800(k,2:4);
   br31600_br33800(:,8)=dist31600(k,25);
end

k=find(dist31600(:,26)<=36);
if length(k)~=0;
   br31600_br34000(:,1)=dist31600(k,1);
   br31600_br34000(:,2:4)=br31600(k,2:4);
   br31600_br34000(:,5:7)=br34000(k,2:4);
   br31600_br34000(:,8)=dist31600(k,26);
end

k=find(dist31600(:,27)<=36);
if length(k)~=0;
   br31600_br34200(:,1)=dist31600(k,1);
   br31600_br34200(:,2:4)=br31600(k,2:4);
   br31600_br34200(:,5:7)=br34200(k,2:4);
   br31600_br34200(:,8)=dist31600(k,27);
end

k=find(dist31600(:,28)<=36);
if length(k)~=0;
   br31600_br34300(:,1)=dist31600(k,1);
   br31600_br34300(:,2:4)=br31600(k,2:4);
   br31600_br34300(:,5:7)=br34300(k,2:4);
   br31600_br34300(:,8)=dist31600(k,28);
end

k=find(dist31600(:,29)<=36);
if length(k)~=0;
   br31600_br34600(:,1)=dist31600(k,1);
   br31600_br34600(:,2:4)=br31600(k,2:4);
   br31600_br34600(:,5:7)=br34600(k,2:4);
   br31600_br34600(:,8)=dist31600(k,29);
end

k=find(dist31600(:,30)<=36);
if length(k)~=0;
   br31600_br34800(:,1)=dist31600(k,1);
```

```
      br31600_br34800(:,2:4)=br31600(k,2:4);
      br31600_br34800(:,5:7)=br34800(k,2:4);
      br31600_br34800(:,8)=dist31600(k,30);
   end

   k=find(dist31600(:,31)<=36);
   if length(k)~=0;
      br31600_br34900(:,1)=dist31600(k,1);
      br31600_br34900(:,2:4)=br31600(k,2:4);
      br31600_br34900(:,5:7)=br34900(k,2:4);
      br31600_br34900(:,8)=dist31600(k,31);
   end

   k=find(dist31600(:,32)<=36);
   if length(k)~=0;
      br31600_br35000(:,1)=dist31600(k,1);
      br31600_br35000(:,2:4)=br31600(k,2:4);
      br31600_br35000(:,5:7)=br35000(k,2:4);
      br31600_br35000(:,8)=dist31600(k,32);
   end
end

if isempty(dist31800);
else
   k=find(dist31800(:,13)<=36);
   if length(k)~=0;
      br31800_br32100(:,1)=dist31800(k,1);
      br31800_br32100(:,2:4)=br31800(k,2:4);
      br31800_br32100(:,5:7)=br32100(k,2:4);
      br31800_br32100(:,8)=dist31800(k,13);
   end

   k=find(dist31800(:,14)<=36);
   if length(k)~=0;
      br31800_br32300(:,1)=dist31800(k,1);
      br31800_br32300(:,2:4)=br31800(k,2:4);
      br31800_br32300(:,5:7)=br32300(k,2:4);
      br31800_br32300(:,8)=dist31800(k,14);
   end

   k=find(dist31800(:,15)<=36);
   if length(k)~=0;
      br31800_br32400(:,1)=dist31800(k,1);
      br31800_br32400(:,2:4)=br31800(k,2:4);
      br31800_br32400(:,5:7)=br32400(k,2:4);
      br31800_br32400(:,8)=dist31800(k,15);
   end

   k=find(dist31800(:,16)<=36);
   if length(k)~=0;
```

```
    br31800_br32500(:,1)=dist31800(k,1);
    br31800_br32500(:,2:4)=br31800(k,2:4);
    br31800_br32500(:,5:7)=br32500(k,2:4);
    br31800_br32500(:,8)=dist31800(k,16);
end

k=find(dist31800(:,17)<=36);
if length(k)~=0;
    br31800_br32700(:,1)=dist31800(k,1);
    br31800_br32700(:,2:4)=br31800(k,2:4);
    br31800_br32700(:,5:7)=br32700(k,2:4);
    br31800_br32700(:,8)=dist31800(k,17);
end

k=find(dist31800(:,18)<=36);
if length(k)~=0;
    br31800_br32900(:,1)=dist31800(k,1);
    br31800_br32900(:,2:4)=br31800(k,2:4);
    br31800_br32900(:,5:7)=br32900(k,2:4);
    br31800_br32900(:,8)=dist31800(k,18);
end

k=find(dist31800(:,19)<=36);
if length(k)~=0;
    br31800_br33000(:,1)=dist31800(k,1);
    br31800_br33000(:,2:4)=br31800(k,2:4);
    br31800_br33000(:,5:7)=br33000(k,2:4);
    br31800_br33000(:,8)=dist31800(k,19);
end

k=find(dist31800(:,20)<=36);
if length(k)~=0;
    br31800_br33200(:,1)=dist31800(k,1);
    br31800_br33200(:,2:4)=br31800(k,2:4);
    br31800_br33200(:,5:7)=br33200(k,2:4);
    br31800_br33200(:,8)=dist31800(k,20);
end

k=find(dist31800(:,21)<=36);
if length(k)~=0;
    br31800_br33300(:,1)=dist31800(k,1);
    br31800_br33300(:,2:4)=br31800(k,2:4);
    br31800_br33300(:,5:7)=br33300(k,2:4);
    br31800_br33300(:,8)=dist31800(k,21);
end

k=find(dist31800(:,22)<=36);
if length(k)~=0;
    br31800_br33500(:,1)=dist31800(k,1);
    br31800_br33500(:,2:4)=br31800(k,2:4);
```

```
    br31800_br33500(:,5:7)=br33500(k,2:4);
    br31800_br33500(:,8)=dist31800(k,22);
end

k=find(dist31800(:,23)<=36);
if length(k)~=0;
    br31800_br33600(:,1)=dist31800(k,1);
    br31800_br33600(:,2:4)=br31800(k,2:4);
    br31800_br33600(:,5:7)=br33600(k,2:4);
    br31800_br33600(:,8)=dist31800(k,23);
end

k=find(dist31800(:,24)<=36);
if length(k)~=0;
    br31800_br33700(:,1)=dist31800(k,1);
    br31800_br33700(:,2:4)=br31800(k,2:4);
    br31800_br33700(:,5:7)=br33700(k,2:4);
    br31800_br33700(:,8)=dist31800(k,24);
end

k=find(dist31800(:,25)<=36);
if length(k)~=0;
    br31800_br33800(:,1)=dist31800(k,1);
    br31800_br33800(:,2:4)=br31800(k,2:4);
    br31800_br33800(:,5:7)=br33800(k,2:4);
    br31800_br33800(:,8)=dist31800(k,25);
end

k=find(dist31800(:,26)<=36);
if length(k)~=0;
    br31800_br34000(:,1)=dist31800(k,1);
    br31800_br34000(:,2:4)=br31800(k,2:4);
    br31800_br34000(:,5:7)=br34000(k,2:4);
    br31800_br34000(:,8)=dist31800(k,26);
end

k=find(dist31800(:,27)<=36);
if length(k)~=0;
    br31800_br34200(:,1)=dist31800(k,1);
    br31800_br34200(:,2:4)=br31800(k,2:4);
    br31800_br34200(:,5:7)=br34200(k,2:4);
    br31800_br34200(:,8)=dist31800(k,27);
end

k=find(dist31800(:,28)<=36);
if length(k)~=0;
    br31800_br34300(:,1)=dist31800(k,1);
    br31800_br34300(:,2:4)=br31800(k,2:4);
    br31800_br34300(:,5:7)=br34300(k,2:4);
    br31800_br34300(:,8)=dist31800(k,28);
```

```
    end

    k=find(dist31800(:,29)<=36);
    if length(k)~=0;
        br31800_br34600(:,1)=dist31800(k,1);
        br31800_br34600(:,2:4)=br31800(k,2:4);
        br31800_br34600(:,5:7)=br34600(k,2:4);
        br31800_br34600(:,8)=dist31800(k,29);
    end

    k=find(dist31800(:,30)<=36);
    if length(k)~=0;
        br31800_br34800(:,1)=dist31800(k,1);
        br31800_br34800(:,2:4)=br31800(k,2:4);
        br31800_br34800(:,5:7)=br34800(k,2:4);
        br31800_br34800(:,8)=dist31800(k,30);
    end

    k=find(dist31800(:,31)<=36);
    if length(k)~=0;
        br31800_br34900(:,1)=dist31800(k,1);
        br31800_br34900(:,2:4)=br31800(k,2:4);
        br31800_br34900(:,5:7)=br34900(k,2:4);
        br31800_br34900(:,8)=dist31800(k,31);
    end

    k=find(dist31800(:,32)<=36);
    if length(k)~=0;
        br31800_br35000(:,1)=dist31800(k,1);
        br31800_br35000(:,2:4)=br31800(k,2:4);
        br31800_br35000(:,5:7)=br35000(k,2:4);
        br31800_br35000(:,8)=dist31800(k,32);
    end
end

if isempty(dist32100);
else
    k=find(dist32100(:,14)<=36);
    if length(k)~=0;
        br32100_br32300(:,1)=dist32100(k,1);
        br32100_br32300(:,2:4)=br32100(k,2:4);
        br32100_br32300(:,5:7)=br32300(k,2:4);
        br32100_br32300(:,8)=dist32100(k,14);
    end

    k=find(dist32100(:,15)<=36);
    if length(k)~=0;
        br32100_br32400(:,1)=dist32100(k,1);
        br32100_br32400(:,2:4)=br32100(k,2:4);
        br32100_br32400(:,5:7)=br32400(k,2:4);
```

```
    br32100_br32400(:,8)=dist32100(k,15);
end

k=find(dist32100(:,16)<=36);
if length(k)~=0;
    br32100_br32500(:,1)=dist32100(k,1);
    br32100_br32500(:,2:4)=br32100(k,2:4);
    br32100_br32500(:,5:7)=br32500(k,2:4);
    br32100_br32500(:,8)=dist32100(k,16);
end

k=find(dist32100(:,17)<=36);
if length(k)~=0;
    br32100_br32700(:,1)=dist32100(k,1);
    br32100_br32700(:,2:4)=br32100(k,2:4);
    br32100_br32700(:,5:7)=br32700(k,2:4);
    br32100_br32700(:,8)=dist32100(k,17);
end

k=find(dist32100(:,18)<=36);
if length(k)~=0;
    br32100_br32900(:,1)=dist32100(k,1);
    br32100_br32900(:,2:4)=br32100(k,2:4);
    br32100_br32900(:,5:7)=br32900(k,2:4);
    br32100_br32900(:,8)=dist32100(k,18);
end

k=find(dist32100(:,19)<=36);
if length(k)~=0;
    br32100_br33000(:,1)=dist32100(k,1);
    br32100_br33000(:,2:4)=br32100(k,2:4);
    br32100_br33000(:,5:7)=br33000(k,2:4);
    br32100_br33000(:,8)=dist32100(k,19);
end

k=find(dist32100(:,20)<=36);
if length(k)~=0;
    br32100_br33200(:,1)=dist32100(k,1);
    br32100_br33200(:,2:4)=br32100(k,2:4);
    br32100_br33200(:,5:7)=br33200(k,2:4);
    br32100_br33200(:,8)=dist32100(k,20);
end

k=find(dist32100(:,21)<=36);
if length(k)~=0;
    br32100_br33300(:,1)=dist32100(k,1);
    br32100_br33300(:,2:4)=br32100(k,2:4);
    br32100_br33300(:,5:7)=br33300(k,2:4);
    br32100_br33300(:,8)=dist32100(k,21);
end
```

```
k=find(dist32100(:,22)<=36);
if length(k)~=0;
   br32100_br33500(:,1)=dist32100(k,1);
   br32100_br33500(:,2:4)=br32100(k,2:4);
   br32100_br33500(:,5:7)=br33500(k,2:4);
   br32100_br33500(:,8)=dist32100(k,22);
end

k=find(dist32100(:,23)<=36);
if length(k)~=0;
   br32100_br33600(:,1)=dist32100(k,1);
   br32100_br33600(:,2:4)=br32100(k,2:4);
   br32100_br33600(:,5:7)=br33600(k,2:4);
   br32100_br33600(:,8)=dist32100(k,23);
end

k=find(dist32100(:,24)<=36);
if length(k)~=0;
   br32100_br33700(:,1)=dist32100(k,1);
   br32100_br33700(:,2:4)=br32100(k,2:4);
   br32100_br33700(:,5:7)=br33700(k,2:4);
   br32100_br33700(:,8)=dist32100(k,24);
end

k=find(dist32100(:,25)<=36);
if length(k)~=0;
   br32100_br33800(:,1)=dist32100(k,1);
   br32100_br33800(:,2:4)=br32100(k,2:4);
   br32100_br33800(:,5:7)=br33800(k,2:4);
   br32100_br33800(:,8)=dist32100(k,25);
end

k=find(dist32100(:,26)<=36);
if length(k)~=0;
   br32100_br34000(:,1)=dist32100(k,1);
   br32100_br34000(:,2:4)=br32100(k,2:4);
   br32100_br34000(:,5:7)=br34000(k,2:4);
   br32100_br34000(:,8)=dist32100(k,26);
end

k=find(dist32100(:,27)<=36);
if length(k)~=0;
   br32100_br34200(:,1)=dist32100(k,1);
   br32100_br34200(:,2:4)=br32100(k,2:4);
   br32100_br34200(:,5:7)=br34200(k,2:4);
   br32100_br34200(:,8)=dist32100(k,27);
end

k=find(dist32100(:,28)<=36);
```

```
    if length(k)~=0;
        br32100_br34300(:,1)=dist32100(k,1);
        br32100_br34300(:,2:4)=br32100(k,2:4);
        br32100_br34300(:,5:7)=br34300(k,2:4);
        br32100_br34300(:,8)=dist32100(k,28);
    end

    k=find(dist32100(:,29)<=36);
    if length(k)~=0;
        br32100_br34600(:,1)=dist32100(k,1);
        br32100_br34600(:,2:4)=br32100(k,2:4);
        br32100_br34600(:,5:7)=br34600(k,2:4);
        br32100_br34600(:,8)=dist32100(k,29);
    end

    k=find(dist32100(:,30)<=36);
    if length(k)~=0;
        br32100_br34800(:,1)=dist32100(k,1);
        br32100_br34800(:,2:4)=br32100(k,2:4);
        br32100_br34800(:,5:7)=br34800(k,2:4);
        br32100_br34800(:,8)=dist32100(k,30);
    end

    k=find(dist32100(:,31)<=36);
    if length(k)~=0;
        br32100_br34900(:,1)=dist32100(k,1);
        br32100_br34900(:,2:4)=br32100(k,2:4);
        br32100_br34900(:,5:7)=br34900(k,2:4);
        br32100_br34900(:,8)=dist32100(k,31);
    end

    k=find(dist32100(:,32)<=36);
    if length(k)~=0;
        br32100_br35000(:,1)=dist32100(k,1);
        br32100_br35000(:,2:4)=br32100(k,2:4);
        br32100_br35000(:,5:7)=br35000(k,2:4);
        br32100_br35000(:,8)=dist32100(k,32);
    end
end

if isempty(dist32300);
else
    k=find(dist32300(:,15)<=36);
    if length(k)~=0;
        br32300_br32400(:,1)=dist32300(k,1);
        br32300_br32400(:,2:4)=br32300(k,2:4);
        br32300_br32400(:,5:7)=br32400(k,2:4);
        br32300_br32400(:,8)=dist32300(k,15);
    end
```

```
k=find(dist32300(:,16)<=36);
if length(k)~=0;
   br32300_br32500(:,1)=dist32300(k,1);
   br32300_br32500(:,2:4)=br32300(k,2:4);
   br32300_br32500(:,5:7)=br32500(k,2:4);
   br32300_br32500(:,8)=dist32300(k,16);
end

k=find(dist32300(:,17)<=36);
if length(k)~=0;
   br32300_br32700(:,1)=dist32300(k,1);
   br32300_br32700(:,2:4)=br32300(k,2:4);
   br32300_br32700(:,5:7)=br32700(k,2:4);
   br32300_br32700(:,8)=dist32300(k,17);
end

k=find(dist32300(:,18)<=36);
if length(k)~=0;
   br32300_br32900(:,1)=dist32300(k,1);
   br32300_br32900(:,2:4)=br32300(k,2:4);
   br32300_br32900(:,5:7)=br32900(k,2:4);
   br32300_br32900(:,8)=dist32300(k,18);
end

k=find(dist32300(:,19)<=36);
if length(k)~=0;
   br32300_br33000(:,1)=dist32300(k,1);
   br32300_br33000(:,2:4)=br32300(k,2:4);
   br32300_br33000(:,5:7)=br33000(k,2:4);
   br32300_br33000(:,8)=dist32300(k,19);
end

k=find(dist32300(:,20)<=36);
if length(k)~=0;
   br32300_br33200(:,1)=dist32300(k,1);
   br32300_br33200(:,2:4)=br32300(k,2:4);
   br32300_br33200(:,5:7)=br33200(k,2:4);
   br32300_br33200(:,8)=dist32300(k,20);
end

k=find(dist32300(:,21)<=36);
if length(k)~=0;
   br32300_br33300(:,1)=dist32300(k,1);
   br32300_br33300(:,2:4)=br32300(k,2:4);
   br32300_br33300(:,5:7)=br33300(k,2:4);
   br32300_br33300(:,8)=dist32300(k,21);
end

k=find(dist32300(:,22)<=36);
if length(k)~=0;
```

```
    br32300_br33500(:,1)=dist32300(k,1);
    br32300_br33500(:,2:4)=br32300(k,2:4);
    br32300_br33500(:,5:7)=br33500(k,2:4);
    br32300_br33500(:,8)=dist32300(k,22);
end

k=find(dist32300(:,23)<=36);
if length(k)~=0;
    br32300_br33600(:,1)=dist32300(k,1);
    br32300_br33600(:,2:4)=br32300(k,2:4);
    br32300_br33600(:,5:7)=br33600(k,2:4);
    br32300_br33600(:,8)=dist32300(k,23);
end

k=find(dist32300(:,24)<=36);
if length(k)~=0;
    br32300_br33700(:,1)=dist32300(k,1);
    br32300_br33700(:,2:4)=br32300(k,2:4);
    br32300_br33700(:,5:7)=br33700(k,2:4);
    br32300_br33700(:,8)=dist32300(k,24);
end

k=find(dist32300(:,25)<=36);
if length(k)~=0;
    br32300_br33800(:,1)=dist32300(k,1);
    br32300_br33800(:,2:4)=br32300(k,2:4);
    br32300_br33800(:,5:7)=br33800(k,2:4);
    br32300_br33800(:,8)=dist32300(k,25);
end

k=find(dist32300(:,26)<=36);
if length(k)~=0;
    br32300_br34000(:,1)=dist32300(k,1);
    br32300_br34000(:,2:4)=br32300(k,2:4);
    br32300_br34000(:,5:7)=br34000(k,2:4);
    br32300_br34000(:,8)=dist32300(k,26);
end

k=find(dist32300(:,27)<=36);
if length(k)~=0;
    br32300_br34200(:,1)=dist32300(k,1);
    br32300_br34200(:,2:4)=br32300(k,2:4);
    br32300_br34200(:,5:7)=br34200(k,2:4);
    br32300_br34200(:,8)=dist32300(k,27);
end

k=find(dist32300(:,28)<=36);
if length(k)~=0;
    br32300_br34300(:,1)=dist32300(k,1);
    br32300_br34300(:,2:4)=br32300(k,2:4);
```

```
        br32300_br34300(:,5:7)=br34300(k,2:4);
        br32300_br34300(:,8)=dist32300(k,28);
    end

    k=find(dist32300(:,29)<=36);
    if length(k)~=0;
        br32300_br34600(:,1)=dist32300(k,1);
        br32300_br34600(:,2:4)=br32300(k,2:4);
        br32300_br34600(:,5:7)=br34600(k,2:4);
        br32300_br34600(:,8)=dist32300(k,29);
    end

    k=find(dist32300(:,30)<=36);
    if length(k)~=0;
        br32300_br34800(:,1)=dist32300(k,1);
        br32300_br34800(:,2:4)=br32300(k,2:4);
        br32300_br34800(:,5:7)=br34800(k,2:4);
        br32300_br34800(:,8)=dist32300(k,30);
    end

    k=find(dist32300(:,31)<=36);
    if length(k)~=0;
        br32300_br34900(:,1)=dist32300(k,1);
        br32300_br34900(:,2:4)=br32300(k,2:4);
        br32300_br34900(:,5:7)=br34900(k,2:4);
        br32300_br34900(:,8)=dist32300(k,31);
    end

    k=find(dist32300(:,32)<=36);
    if length(k)~=0;
        br32300_br35000(:,1)=dist32300(k,1);
        br32300_br35000(:,2:4)=br32300(k,2:4);
        br32300_br35000(:,5:7)=br35000(k,2:4);
        br32300_br35000(:,8)=dist32300(k,32);
    end
end

if isempty(dist32400);
else
    k=find(dist32400(:,16)<=36);
    if length(k)~=0;
        br32400_br32500(:,1)=dist32400(k,1);
        br32400_br32500(:,2:4)=br32400(k,2:4);
        br32400_br32500(:,5:7)=br32500(k,2:4);
        br32400_br32500(:,8)=dist32400(k,16);
    end

    k=find(dist32400(:,17)<=36);
    if length(k)~=0;
        br32400_br32700(:,1)=dist32400(k,1);
```

```
    br32400_br32700(:,2:4)=br32400(k,2:4);
    br32400_br32700(:,5:7)=br32700(k,2:4);
    br32400_br32700(:,8)=dist32400(k,17);
end

k=find(dist32400(:,18)<=36);
if length(k)~=0;
    br32400_br32900(:,1)=dist32400(k,1);
    br32400_br32900(:,2:4)=br32400(k,2:4);
    br32400_br32900(:,5:7)=br32900(k,2:4);
    br32400_br32900(:,8)=dist32400(k,18);
end

k=find(dist32400(:,19)<=36);
if length(k)~=0;
    br32400_br33000(:,1)=dist32400(k,1);
    br32400_br33000(:,2:4)=br32400(k,2:4);
    br32400_br33000(:,5:7)=br33000(k,2:4);
    br32400_br33000(:,8)=dist32400(k,19);
end

k=find(dist32400(:,20)<=36);
if length(k)~=0;
    br32400_br33200(:,1)=dist32400(k,1);
    br32400_br33200(:,2:4)=br32400(k,2:4);
    br32400_br33200(:,5:7)=br33200(k,2:4);
    br32400_br33200(:,8)=dist32400(k,20);
end

k=find(dist32400(:,21)<=36);
if length(k)~=0;
    br32400_br33300(:,1)=dist32400(k,1);
    br32400_br33300(:,2:4)=br32400(k,2:4);
    br32400_br33300(:,5:7)=br33300(k,2:4);
    br32400_br33300(:,8)=dist32400(k,21);
end

k=find(dist32400(:,22)<=36);
if length(k)~=0;
    br32400_br33500(:,1)=dist32400(k,1);
    br32400_br33500(:,2:4)=br32400(k,2:4);
    br32400_br33500(:,5:7)=br33500(k,2:4);
    br32400_br33500(:,8)=dist32400(k,22);
end

k=find(dist32400(:,23)<=36);
if length(k)~=0;
    br32400_br33600(:,1)=dist32400(k,1);
    br32400_br33600(:,2:4)=br32400(k,2:4);
    br32400_br33600(:,5:7)=br33600(k,2:4);
```

```
    br32400_br33600(:,8)=dist32400(k,23);
end

k=find(dist32400(:,24)<=36);
if length(k)~=0;
    br32400_br33700(:,1)=dist32400(k,1);
    br32400_br33700(:,2:4)=br32400(k,2:4);
    br32400_br33700(:,5:7)=br33700(k,2:4);
    br32400_br33700(:,8)=dist32400(k,24);
end

k=find(dist32400(:,25)<=36);
if length(k)~=0;
    br32400_br33800(:,1)=dist32400(k,1);
    br32400_br33800(:,2:4)=br32400(k,2:4);
    br32400_br33800(:,5:7)=br33800(k,2:4);
    br32400_br33800(:,8)=dist32400(k,25);
end

k=find(dist32400(:,26)<=36);
if length(k)~=0;
    br32400_br34000(:,1)=dist32400(k,1);
    br32400_br34000(:,2:4)=br32400(k,2:4);
    br32400_br34000(:,5:7)=br34000(k,2:4);
    br32400_br34000(:,8)=dist32400(k,26);
end

k=find(dist32400(:,27)<=36);
if length(k)~=0;
    br32400_br34200(:,1)=dist32400(k,1);
    br32400_br34200(:,2:4)=br32400(k,2:4);
    br32400_br34200(:,5:7)=br34200(k,2:4);
    br32400_br34200(:,8)=dist32400(k,27);
end

k=find(dist32400(:,28)<=36);
if length(k)~=0;
    br32400_br34300(:,1)=dist32400(k,1);
    br32400_br34300(:,2:4)=br32400(k,2:4);
    br32400_br34300(:,5:7)=br34300(k,2:4);
    br32400_br34300(:,8)=dist32400(k,28);
end

k=find(dist32400(:,29)<=36);
if length(k)~=0;
    br32400_br34600(:,1)=dist32400(k,1);
    br32400_br34600(:,2:4)=br32400(k,2:4);
    br32400_br34600(:,5:7)=br34600(k,2:4);
    br32400_br34600(:,8)=dist32400(k,29);
end
```

```
    k=find(dist32400(:,30)<=36);
    if length(k)~=0;
        br32400_br34800(:,1)=dist32400(k,1);
        br32400_br34800(:,2:4)=br32400(k,2:4);
        br32400_br34800(:,5:7)=br34800(k,2:4);
        br32400_br34800(:,8)=dist32400(k,30);
    end

    k=find(dist32400(:,31)<=36);
    if length(k)~=0;
        br32400_br34900(:,1)=dist32400(k,1);
        br32400_br34900(:,2:4)=br32400(k,2:4);
        br32400_br34900(:,5:7)=br34900(k,2:4);
        br32400_br34900(:,8)=dist32400(k,31);
    end

    k=find(dist32400(:,32)<=36);
    if length(k)~=0;
        br32400_br35000(:,1)=dist32400(k,1);
        br32400_br35000(:,2:4)=br32400(k,2:4);
        br32400_br35000(:,5:7)=br35000(k,2:4);
        br32400_br35000(:,8)=dist32400(k,32);
    end
end

if isempty(dist32500);
else
    k=find(dist32500(:,17)<=36);
    if length(k)~=0;
        br32500_br32700(:,1)=dist32500(k,1);
        br32500_br32700(:,2:4)=br32500(k,2:4);
        br32500_br32700(:,5:7)=br32700(k,2:4);
        br32500_br32700(:,8)=dist32500(k,17);
    end

    k=find(dist32500(:,18)<=36);
    if length(k)~=0;
        br32500_br32900(:,1)=dist32500(k,1);
        br32500_br32900(:,2:4)=br32500(k,2:4);
        br32500_br32900(:,5:7)=br32900(k,2:4);
        br32500_br32900(:,8)=dist32500(k,18);
    end

    k=find(dist32500(:,19)<=36);
    if length(k)~=0;
        br32500_br33000(:,1)=dist32500(k,1);
        br32500_br33000(:,2:4)=br32500(k,2:4);
        br32500_br33000(:,5:7)=br33000(k,2:4);
        br32500_br33000(:,8)=dist32500(k,19);
```

```
end

k=find(dist32500(:,20)<=36);
if length(k)~=0;
   br32500_br33200(:,1)=dist32500(k,1);
   br32500_br33200(:,2:4)=br32500(k,2:4);
   br32500_br33200(:,5:7)=br33200(k,2:4);
   br32500_br33200(:,8)=dist32500(k,20);
end

k=find(dist32500(:,21)<=36);
if length(k)~=0;
   br32500_br33300(:,1)=dist32500(k,1);
   br32500_br33300(:,2:4)=br32500(k,2:4);
   br32500_br33300(:,5:7)=br33300(k,2:4);
   br32500_br33300(:,8)=dist32500(k,21);
end

k=find(dist32500(:,22)<=36);
if length(k)~=0;
   br32500_br33500(:,1)=dist32500(k,1);
   br32500_br33500(:,2:4)=br32500(k,2:4);
   br32500_br33500(:,5:7)=br33500(k,2:4);
   br32500_br33500(:,8)=dist32500(k,22);
end

k=find(dist32500(:,23)<=36);
if length(k)~=0;
   br32500_br33600(:,1)=dist32500(k,1);
   br32500_br33600(:,2:4)=br32500(k,2:4);
   br32500_br33600(:,5:7)=br33600(k,2:4);
   br32500_br33600(:,8)=dist32500(k,23);
end

k=find(dist32500(:,24)<=36);
if length(k)~=0;
   br32500_br33700(:,1)=dist32500(k,1);
   br32500_br33700(:,2:4)=br32500(k,2:4);
   br32500_br33700(:,5:7)=br33700(k,2:4);
   br32500_br33700(:,8)=dist32500(k,24);
end

k=find(dist32500(:,25)<=36);
if length(k)~=0;
   br32500_br33800(:,1)=dist32500(k,1);
   br32500_br33800(:,2:4)=br32500(k,2:4);
   br32500_br33800(:,5:7)=br33800(k,2:4);
   br32500_br33800(:,8)=dist32500(k,25);
end
```

```
k=find(dist32500(:,26)<=36);
if length(k)~=0;
   br32500_br34000(:,1)=dist32500(k,1);
   br32500_br34000(:,2:4)=br32500(k,2:4);
   br32500_br34000(:,5:7)=br34000(k,2:4);
   br32500_br34000(:,8)=dist32500(k,26);
end

k=find(dist32500(:,27)<=36);
if length(k)~=0;
   br32500_br34200(:,1)=dist32500(k,1);
   br32500_br34200(:,2:4)=br32500(k,2:4);
   br32500_br34200(:,5:7)=br34200(k,2:4);
   br32500_br34200(:,8)=dist32500(k,27);
end

k=find(dist32500(:,28)<=36);
if length(k)~=0;
   br32500_br34300(:,1)=dist32500(k,1);
   br32500_br34300(:,2:4)=br32500(k,2:4);
   br32500_br34300(:,5:7)=br34300(k,2:4);
   br32500_br34300(:,8)=dist32500(k,28);
end

k=find(dist32500(:,29)<=36);
if length(k)~=0;
   br32500_br34600(:,1)=dist32500(k,1);
   br32500_br34600(:,2:4)=br32500(k,2:4);
   br32500_br34600(:,5:7)=br34600(k,2:4);
   br32500_br34600(:,8)=dist32500(k,29);
end

k=find(dist32500(:,30)<=36);
if length(k)~=0;
   br32500_br34800(:,1)=dist32500(k,1);
   br32500_br34800(:,2:4)=br32500(k,2:4);
   br32500_br34800(:,5:7)=br34800(k,2:4);
   br32500_br34800(:,8)=dist32500(k,30);
end

k=find(dist32500(:,31)<=36);
if length(k)~=0;
   br32500_br34900(:,1)=dist32500(k,1);
   br32500_br34900(:,2:4)=br32500(k,2:4);
   br32500_br34900(:,5:7)=br34900(k,2:4);
   br32500_br34900(:,8)=dist32500(k,31);
end

k=find(dist32500(:,32)<=36);
if length(k)~=0;
```

```
        br32500_br35000(:,1)=dist32500(k,1);
        br32500_br35000(:,2:4)=br32500(k,2:4);
        br32500_br35000(:,5:7)=br35000(k,2:4);
        br32500_br35000(:,8)=dist32500(k,32);
    end
end

if isempty(dist32700);
else
    k=find(dist32700(:,18)<=36);
    if length(k)~=0;
        br32700_br32900(:,1)=dist32700(k,1);
        br32700_br32900(:,2:4)=br32700(k,2:4);
        br32700_br32900(:,5:7)=br32900(k,2:4);
        br32700_br32900(:,8)=dist32700(k,18);
    end

    k=find(dist32700(:,19)<=36);
    if length(k)~=0;
        br32700_br33000(:,1)=dist32700(k,1);
        br32700_br33000(:,2:4)=br32700(k,2:4);
        br32700_br33000(:,5:7)=br33000(k,2:4);
        br32700_br33000(:,8)=dist32700(k,19);
    end

    k=find(dist32700(:,20)<=36);
    if length(k)~=0;
        br32700_br33200(:,1)=dist32700(k,1);
        br32700_br33200(:,2:4)=br32700(k,2:4);
        br32700_br33200(:,5:7)=br33200(k,2:4);
        br32700_br33200(:,8)=dist32700(k,20);
    end

    k=find(dist32700(:,21)<=36);
    if length(k)~=0;
        br32700_br33300(:,1)=dist32700(k,1);
        br32700_br33300(:,2:4)=br32700(k,2:4);
        br32700_br33300(:,5:7)=br33300(k,2:4);
        br32700_br33300(:,8)=dist32700(k,21);
    end

    k=find(dist32700(:,22)<=36);
    if length(k)~=0;
        br32700_br33500(:,1)=dist32700(k,1);
        br32700_br33500(:,2:4)=br32700(k,2:4);
        br32700_br33500(:,5:7)=br33500(k,2:4);
        br32700_br33500(:,8)=dist32700(k,22);
    end

    k=find(dist32700(:,23)<=36);
```

```
if length(k)~=0;
    br32700_br33600(:,1)=dist32700(k,1);
    br32700_br33600(:,2:4)=br32700(k,2:4);
    br32700_br33600(:,5:7)=br33600(k,2:4);
    br32700_br33600(:,8)=dist32700(k,23);
end

k=find(dist32700(:,24)<=36);
if length(k)~=0;
    br32700_br33700(:,1)=dist32700(k,1);
    br32700_br33700(:,2:4)=br32700(k,2:4);
    br32700_br33700(:,5:7)=br33700(k,2:4);
    br32700_br33700(:,8)=dist32700(k,24);
end

k=find(dist32700(:,25)<=36);
if length(k)~=0;
    br32700_br33800(:,1)=dist32700(k,1);
    br32700_br33800(:,2:4)=br32700(k,2:4);
    br32700_br33800(:,5:7)=br33800(k,2:4);
    br32700_br33800(:,8)=dist32700(k,25);
end

k=find(dist32700(:,26)<=36);
if length(k)~=0;
    br32700_br34000(:,1)=dist32700(k,1);
    br32700_br34000(:,2:4)=br32700(k,2:4);
    br32700_br34000(:,5:7)=br34000(k,2:4);
    br32700_br34000(:,8)=dist32700(k,26);
end

k=find(dist32700(:,27)<=36);
if length(k)~=0;
    br32700_br34200(:,1)=dist32700(k,1);
    br32700_br34200(:,2:4)=br32700(k,2:4);
    br32700_br34200(:,5:7)=br34200(k,2:4);
    br32700_br34200(:,8)=dist32700(k,27);
end

k=find(dist32700(:,28)<=36);
if length(k)~=0;
    br32700_br34300(:,1)=dist32700(k,1);
    br32700_br34300(:,2:4)=br32700(k,2:4);
    br32700_br34300(:,5:7)=br34300(k,2:4);
    br32700_br34300(:,8)=dist32700(k,28);
end

k=find(dist32700(:,29)<=36);
if length(k)~=0;
    br32700_br34600(:,1)=dist32700(k,1);
```

```
        br32700_br34600(:,2:4)=br32700(k,2:4);
        br32700_br34600(:,5:7)=br34600(k,2:4);
        br32700_br34600(:,8)=dist32700(k,29);
    end

    k=find(dist32700(:,30)<=36);
    if length(k)~=0;
        br32700_br34800(:,1)=dist32700(k,1);
        br32700_br34800(:,2:4)=br32700(k,2:4);
        br32700_br34800(:,5:7)=br34800(k,2:4);
        br32700_br34800(:,8)=dist32700(k,30);
    end

    k=find(dist32700(:,31)<=36);
    if length(k)~=0;
        br32700_br34900(:,1)=dist32700(k,1);
        br32700_br34900(:,2:4)=br32700(k,2:4);
        br32700_br34900(:,5:7)=br34900(k,2:4);
        br32700_br34900(:,8)=dist32700(k,31);
    end

    k=find(dist32700(:,32)<=36);
    if length(k)~=0;
        br32700_br35000(:,1)=dist32700(k,1);
        br32700_br35000(:,2:4)=br32700(k,2:4);
        br32700_br35000(:,5:7)=br35000(k,2:4);
        br32700_br35000(:,8)=dist32700(k,32);
    end
end

if isempty(dist32900);
else
    k=find(dist32900(:,19)<=36);
    if length(k)~=0;
        br32900_br33000(:,1)=dist32900(k,1);
        br32900_br33000(:,2:4)=br32900(k,2:4);
        br32900_br33000(:,5:7)=br33000(k,2:4);
        br32900_br33000(:,8)=dist32900(k,19);
    end

    k=find(dist32900(:,20)<=36);
    if length(k)~=0;
        br32900_br33200(:,1)=dist32900(k,1);
        br32900_br33200(:,2:4)=br32900(k,2:4);
        br32900_br33200(:,5:7)=br33200(k,2:4);
        br32900_br33200(:,8)=dist32900(k,20);
    end

    k=find(dist32900(:,21)<=36);
    if length(k)~=0;
```

```
    br32900_br33300(:,1)=dist32900(k,1);
    br32900_br33300(:,2:4)=br32900(k,2:4);
    br32900_br33300(:,5:7)=br33300(k,2:4);
    br32900_br33300(:,8)=dist32900(k,21);
end

k=find(dist32900(:,22)<=36);
if length(k)~=0;
    br32900_br33500(:,1)=dist32900(k,1);
    br32900_br33500(:,2:4)=br32900(k,2:4);
    br32900_br33500(:,5:7)=br33500(k,2:4);
    br32900_br33500(:,8)=dist32900(k,22);
end

k=find(dist32900(:,23)<=36);
if length(k)~=0;
    br32900_br33600(:,1)=dist32900(k,1);
    br32900_br33600(:,2:4)=br32900(k,2:4);
    br32900_br33600(:,5:7)=br33600(k,2:4);
    br32900_br33600(:,8)=dist32900(k,23);
end

k=find(dist32900(:,24)<=36);
if length(k)~=0;
    br32900_br33700(:,1)=dist32900(k,1);
    br32900_br33700(:,2:4)=br32900(k,2:4);
    br32900_br33700(:,5:7)=br33700(k,2:4);
    br32900_br33700(:,8)=dist32900(k,24);
end

k=find(dist32900(:,25)<=36);
if length(k)~=0;
    br32900_br33800(:,1)=dist32900(k,1);
    br32900_br33800(:,2:4)=br32900(k,2:4);
    br32900_br33800(:,5:7)=br33800(k,2:4);
    br32900_br33800(:,8)=dist32900(k,25);
end

k=find(dist32900(:,26)<=36);
if length(k)~=0;
    br32900_br34000(:,1)=dist32900(k,1);
    br32900_br34000(:,2:4)=br32900(k,2:4);
    br32900_br34000(:,5:7)=br34000(k,2:4);
    br32900_br34000(:,8)=dist32900(k,26);
end

k=find(dist32900(:,27)<=36);
if length(k)~=0;
    br32900_br34200(:,1)=dist32900(k,1);
    br32900_br34200(:,2:4)=br32900(k,2:4);
```

```
        br32900_br34200(:,5:7)=br34200(k,2:4);
        br32900_br34200(:,8)=dist32900(k,27);
    end

    k=find(dist32900(:,28)<=36);
    if length(k)~=0;
        br32900_br34300(:,1)=dist32900(k,1);
        br32900_br34300(:,2:4)=br32900(k,2:4);
        br32900_br34300(:,5:7)=br34300(k,2:4);
        br32900_br34300(:,8)=dist32900(k,28);
    end

    k=find(dist32900(:,29)<=36);
    if length(k)~=0;
        br32900_br34600(:,1)=dist32900(k,1);
        br32900_br34600(:,2:4)=br32900(k,2:4);
        br32900_br34600(:,5:7)=br34600(k,2:4);
        br32900_br34600(:,8)=dist32900(k,29);
    end

    k=find(dist32900(:,30)<=36);
    if length(k)~=0;
        br32900_br34800(:,1)=dist32900(k,1);
        br32900_br34800(:,2:4)=br32900(k,2:4);
        br32900_br34800(:,5:7)=br34800(k,2:4);
        br32900_br34800(:,8)=dist32900(k,30);
    end

    k=find(dist32900(:,31)<=36);
    if length(k)~=0;
        br32900_br34900(:,1)=dist32900(k,1);
        br32900_br34900(:,2:4)=br32900(k,2:4);
        br32900_br34900(:,5:7)=br34900(k,2:4);
        br32900_br34900(:,8)=dist32900(k,31);
    end

    k=find(dist32900(:,32)<=36);
    if length(k)~=0;
        br32900_br35000(:,1)=dist32900(k,1);
        br32900_br35000(:,2:4)=br32900(k,2:4);
        br32900_br35000(:,5:7)=br35000(k,2:4);
        br32900_br35000(:,8)=dist32900(k,32);
    end
end

if isempty(dist33000);
else
    k=find(dist33000(:,20)<=36);
    if length(k)~=0;
        br33000_br33200(:,1)=dist33000(k,1);
```

```
    br33000_br33200(:,2:4)=br33000(k,2:4);
    br33000_br33200(:,5:7)=br33200(k,2:4);
    br33000_br33200(:,8)=dist33000(k,20);
end

k=find(dist33000(:,21)<=36);
if length(k)~=0;
    br33000_br33300(:,1)=dist33000(k,1);
    br33000_br33300(:,2:4)=br33000(k,2:4);
    br33000_br33300(:,5:7)=br33300(k,2:4);
    br33000_br33300(:,8)=dist33000(k,21);
end

k=find(dist33000(:,22)<=36);
if length(k)~=0;
    br33000_br33500(:,1)=dist33000(k,1);
    br33000_br33500(:,2:4)=br33000(k,2:4);
    br33000_br33500(:,5:7)=br33500(k,2:4);
    br33000_br33500(:,8)=dist33000(k,22);
end

k=find(dist33000(:,23)<=36);
if length(k)~=0;
    br33000_br33600(:,1)=dist33000(k,1);
    br33000_br33600(:,2:4)=br33000(k,2:4);
    br33000_br33600(:,5:7)=br33600(k,2:4);
    br33000_br33600(:,8)=dist33000(k,23);
end

k=find(dist33000(:,24)<=36);
if length(k)~=0;
    br33000_br33700(:,1)=dist33000(k,1);
    br33000_br33700(:,2:4)=br33000(k,2:4);
    br33000_br33700(:,5:7)=br33700(k,2:4);
    br33000_br33700(:,8)=dist33000(k,24);
end

k=find(dist33000(:,25)<=36);
if length(k)~=0;
    br33000_br33800(:,1)=dist33000(k,1);
    br33000_br33800(:,2:4)=br33000(k,2:4);
    br33000_br33800(:,5:7)=br33800(k,2:4);
    br33000_br33800(:,8)=dist33000(k,25);
end

k=find(dist33000(:,26)<=36);
if length(k)~=0;
    br33000_br34000(:,1)=dist33000(k,1);
    br33000_br34000(:,2:4)=br33000(k,2:4);
    br33000_br34000(:,5:7)=br34000(k,2:4);
```

```
    br33000_br34000(:,8)=dist33000(k,26);
end

k=find(dist33000(:,27)<=36);
if length(k)~=0;
    br33000_br34200(:,1)=dist33000(k,1);
    br33000_br34200(:,2:4)=br33000(k,2:4);
    br33000_br34200(:,5:7)=br34200(k,2:4);
    br33000_br34200(:,8)=dist33000(k,27);
end

k=find(dist33000(:,28)<=36);
if length(k)~=0;
    br33000_br34300(:,1)=dist33000(k,1);
    br33000_br34300(:,2:4)=br33000(k,2:4);
    br33000_br34300(:,5:7)=br34300(k,2:4);
    br33000_br34300(:,8)=dist33000(k,28);
end

k=find(dist33000(:,29)<=36);
if length(k)~=0;
    br33000_br34600(:,1)=dist33000(k,1);
    br33000_br34600(:,2:4)=br33000(k,2:4);
    br33000_br34600(:,5:7)=br34600(k,2:4);
    br33000_br34600(:,8)=dist33000(k,29);
end

k=find(dist33000(:,30)<=36);
if length(k)~=0;
    br33000_br34800(:,1)=dist33000(k,1);
    br33000_br34800(:,2:4)=br33000(k,2:4);
    br33000_br34800(:,5:7)=br34800(k,2:4);
    br33000_br34800(:,8)=dist33000(k,30);
end

k=find(dist33000(:,31)<=36);
if length(k)~=0;
    br33000_br34900(:,1)=dist33000(k,1);
    br33000_br34900(:,2:4)=br33000(k,2:4);
    br33000_br34900(:,5:7)=br34900(k,2:4);
    br33000_br34900(:,8)=dist33000(k,31);
end

k=find(dist33000(:,32)<=36);
if length(k)~=0;
    br33000_br35000(:,1)=dist33000(k,1);
    br33000_br35000(:,2:4)=br33000(k,2:4);
    br33000_br35000(:,5:7)=br35000(k,2:4);
    br33000_br35000(:,8)=dist33000(k,32);
end
```

```
end

if isempty(dist33200);
else
   k=find(dist33200(:,21)<=36);
   if length(k)~=0;
      br33200_br33300(:,1)=dist33200(k,1);
      br33200_br33300(:,2:4)=br33200(k,2:4);
      br33200_br33300(:,5:7)=br33300(k,2:4);
      br33200_br33300(:,8)=dist33200(k,21);
   end

   k=find(dist33200(:,22)<=36);
   if length(k)~=0;
      br33200_br33500(:,1)=dist33200(k,1);
      br33200_br33500(:,2:4)=br33200(k,2:4);
      br33200_br33500(:,5:7)=br33500(k,2:4);
      br33200_br33500(:,8)=dist33200(k,22);
   end

   k=find(dist33200(:,23)<=36);
   if length(k)~=0;
      br33200_br33600(:,1)=dist33200(k,1);
      br33200_br33600(:,2:4)=br33200(k,2:4);
      br33200_br33600(:,5:7)=br33600(k,2:4);
      br33200_br33600(:,8)=dist33200(k,23);
   end

   k=find(dist33200(:,24)<=36);
   if length(k)~=0;
      br33200_br33700(:,1)=dist33200(k,1);
      br33200_br33700(:,2:4)=br33200(k,2:4);
      br33200_br33700(:,5:7)=br33700(k,2:4);
      br33200_br33700(:,8)=dist33200(k,24);
   end

   k=find(dist33200(:,25)<=36);
   if length(k)~=0;
      br33200_br33800(:,1)=dist33200(k,1);
      br33200_br33800(:,2:4)=br33200(k,2:4);
      br33200_br33800(:,5:7)=br33800(k,2:4);
      br33200_br33800(:,8)=dist33200(k,25);
   end

   k=find(dist33200(:,26)<=36);
   if length(k)~=0;
      br33200_br34000(:,1)=dist33200(k,1);
      br33200_br34000(:,2:4)=br33200(k,2:4);
      br33200_br34000(:,5:7)=br34000(k,2:4);
      br33200_br34000(:,8)=dist33200(k,26);
```

```
    end

    k=find(dist33200(:,27)<=36);
    if length(k)~=0;
       br33200_br34200(:,1)=dist33200(k,1);
       br33200_br34200(:,2:4)=br33200(k,2:4);
       br33200_br34200(:,5:7)=br34200(k,2:4);
       br33200_br34200(:,8)=dist33200(k,27);
    end

    k=find(dist33200(:,28)<=36);
    if length(k)~=0;
       br33200_br34300(:,1)=dist33200(k,1);
       br33200_br34300(:,2:4)=br33200(k,2:4);
       br33200_br34300(:,5:7)=br34300(k,2:4);
       br33200_br34300(:,8)=dist33200(k,28);
    end

    k=find(dist33200(:,29)<=36);
    if length(k)~=0;
       br33200_br34600(:,1)=dist33200(k,1);
       br33200_br34600(:,2:4)=br33200(k,2:4);
       br33200_br34600(:,5:7)=br34600(k,2:4);
       br33200_br34600(:,8)=dist33200(k,29);
    end

    k=find(dist33200(:,30)<=36);
    if length(k)~=0;
       br33200_br34800(:,1)=dist33200(k,1);
       br33200_br34800(:,2:4)=br33200(k,2:4);
       br33200_br34800(:,5:7)=br34800(k,2:4);
       br33200_br34800(:,8)=dist33200(k,30);
    end

    k=find(dist33200(:,31)<=36);
    if length(k)~=0;
       br33200_br34900(:,1)=dist33200(k,1);
       br33200_br34900(:,2:4)=br33200(k,2:4);
       br33200_br34900(:,5:7)=br34900(k,2:4);
       br33200_br34900(:,8)=dist33200(k,31);
    end

    k=find(dist33200(:,32)<=36);
    if length(k)~=0;
       br33200_br35000(:,1)=dist33200(k,1);
       br33200_br35000(:,2:4)=br33200(k,2:4);
       br33200_br35000(:,5:7)=br35000(k,2:4);
       br33200_br35000(:,8)=dist33200(k,32);
    end
end
```

```
if isempty(dist33300);
else
   k=find(dist33300(:,22)<=36);
   if length(k)~=0;
      br33300_br33500(:,1)=dist33300(k,1);
      br33300_br33500(:,2:4)=br33300(k,2:4);
      br33300_br33500(:,5:7)=br33500(k,2:4);
      br33300_br33500(:,8)=dist33300(k,22);
   end

   k=find(dist33300(:,23)<=36);
   if length(k)~=0;
      br33300_br33600(:,1)=dist33300(k,1);
      br33300_br33600(:,2:4)=br33300(k,2:4);
      br33300_br33600(:,5:7)=br33600(k,2:4);
      br33300_br33600(:,8)=dist33300(k,23);
   end

   k=find(dist33300(:,24)<=36);
   if length(k)~=0;
      br33300_br33700(:,1)=dist33300(k,1);
      br33300_br33700(:,2:4)=br33300(k,2:4);
      br33300_br33700(:,5:7)=br33700(k,2:4);
      br33300_br33700(:,8)=dist33300(k,24);
   end

   k=find(dist33300(:,25)<=36);
   if length(k)~=0;
      br33300_br33800(:,1)=dist33300(k,1);
      br33300_br33800(:,2:4)=br33300(k,2:4);
      br33300_br33800(:,5:7)=br33800(k,2:4);
      br33300_br33800(:,8)=dist33300(k,25);
   end

   k=find(dist33300(:,26)<=36);
   if length(k)~=0;
      br33300_br34000(:,1)=dist33300(k,1);
      br33300_br34000(:,2:4)=br33300(k,2:4);
      br33300_br34000(:,5:7)=br34000(k,2:4);
      br33300_br34000(:,8)=dist33300(k,26);
   end

   k=find(dist33300(:,27)<=36);
   if length(k)~=0;
      br33300_br34200(:,1)=dist33300(k,1);
      br33300_br34200(:,2:4)=br33300(k,2:4);
      br33300_br34200(:,5:7)=br34200(k,2:4);
      br33300_br34200(:,8)=dist33300(k,27);
   end
```

```
    k=find(dist33300(:,28)<=36);
    if length(k)~=0;
        br33300_br34300(:,1)=dist33300(k,1);
        br33300_br34300(:,2:4)=br33300(k,2:4);
        br33300_br34300(:,5:7)=br34300(k,2:4);
        br33300_br34300(:,8)=dist33300(k,28);
    end

    k=find(dist33300(:,29)<=36);
    if length(k)~=0;
        br33300_br34600(:,1)=dist33300(k,1);
        br33300_br34600(:,2:4)=br33300(k,2:4);
        br33300_br34600(:,5:7)=br34600(k,2:4);
        br33300_br34600(:,8)=dist33300(k,29);
    end

    k=find(dist33300(:,30)<=36);
    if length(k)~=0;
        br33300_br34800(:,1)=dist33300(k,1);
        br33300_br34800(:,2:4)=br33300(k,2:4);
        br33300_br34800(:,5:7)=br34800(k,2:4);
        br33300_br34800(:,8)=dist33300(k,30);
    end

    k=find(dist33300(:,31)<=36);
    if length(k)~=0;
        br33300_br34900(:,1)=dist33300(k,1);
        br33300_br34900(:,2:4)=br33300(k,2:4);
        br33300_br34900(:,5:7)=br34900(k,2:4);
        br33300_br34900(:,8)=dist33300(k,31);
    end

    k=find(dist33300(:,32)<=36);
    if length(k)~=0;
        br33300_br35000(:,1)=dist33300(k,1);
        br33300_br35000(:,2:4)=br33300(k,2:4);
        br33300_br35000(:,5:7)=br35000(k,2:4);
        br33300_br35000(:,8)=dist33300(k,32);
    end
end

if isempty(dist33500);
else
    k=find(dist33500(:,23)<=36);
    if length(k)~=0;
        br33500_br33600(:,1)=dist33500(k,1);
        br33500_br33600(:,2:4)=br33500(k,2:4);
        br33500_br33600(:,5:7)=br33600(k,2:4);
        br33500_br33600(:,8)=dist33500(k,23);
```

```
end

k=find(dist33500(:,24)<=36);
if length(k)~=0;
    br33500_br33700(:,1)=dist33500(k,1);
    br33500_br33700(:,2:4)=br33500(k,2:4);
    br33500_br33700(:,5:7)=br33700(k,2:4);
    br33500_br33700(:,8)=dist33500(k,24);
end

k=find(dist33500(:,25)<=36);
if length(k)~=0;
    br33500_br33800(:,1)=dist33500(k,1);
    br33500_br33800(:,2:4)=br33500(k,2:4);
    br33500_br33800(:,5:7)=br33800(k,2:4);
    br33500_br33800(:,8)=dist33500(k,25);
end

k=find(dist33500(:,26)<=36);
if length(k)~=0;
    br33500_br34000(:,1)=dist33500(k,1);
    br33500_br34000(:,2:4)=br33500(k,2:4);
    br33500_br34000(:,5:7)=br34000(k,2:4);
    br33500_br34000(:,8)=dist33500(k,26);
end

k=find(dist33500(:,27)<=36);
if length(k)~=0;
    br33500_br34200(:,1)=dist33500(k,1);
    br33500_br34200(:,2:4)=br33500(k,2:4);
    br33500_br34200(:,5:7)=br34200(k,2:4);
    br33500_br34200(:,8)=dist33500(k,27);
end

k=find(dist33500(:,28)<=36);
if length(k)~=0;
    br33500_br34300(:,1)=dist33500(k,1);
    br33500_br34300(:,2:4)=br33500(k,2:4);
    br33500_br34300(:,5:7)=br34300(k,2:4);
    br33500_br34300(:,8)=dist33500(k,28);
end

k=find(dist33500(:,29)<=36);
if length(k)~=0;
    br33500_br34600(:,1)=dist33500(k,1);
    br33500_br34600(:,2:4)=br33500(k,2:4);
    br33500_br34600(:,5:7)=br34600(k,2:4);
    br33500_br34600(:,8)=dist33500(k,29);
end
```

```
    k=find(dist33500(:,30)<=36);
    if length(k)~=0;
        br33500_br34800(:,1)=dist33500(k,1);
        br33500_br34800(:,2:4)=br33500(k,2:4);
        br33500_br34800(:,5:7)=br34800(k,2:4);
        br33500_br34800(:,8)=dist33500(k,30);
    end

    k=find(dist33500(:,31)<=36);
    if length(k)~=0;
        br33500_br34900(:,1)=dist33500(k,1);
        br33500_br34900(:,2:4)=br33500(k,2:4);
        br33500_br34900(:,5:7)=br34900(k,2:4);
        br33500_br34900(:,8)=dist33500(k,31);
    end

    k=find(dist33500(:,32)<=36);
    if length(k)~=0;
        br33500_br35000(:,1)=dist33500(k,1);
        br33500_br35000(:,2:4)=br33500(k,2:4);
        br33500_br35000(:,5:7)=br35000(k,2:4);
        br33500_br35000(:,8)=dist33500(k,32);
    end
end

if isempty(dist33600);
else
    k=find(dist33600(:,24)<=36);
    if length(k)~=0;
        br33600_br33700(:,1)=dist33600(k,1);
        br33600_br33700(:,2:4)=br33600(k,2:4);
        br33600_br33700(:,5:7)=br33700(k,2:4);
        br33600_br33700(:,8)=dist33600(k,24);
    end

    k=find(dist33600(:,25)<=36);
    if length(k)~=0;
        br33600_br33800(:,1)=dist33600(k,1);
        br33600_br33800(:,2:4)=br33600(k,2:4);
        br33600_br33800(:,5:7)=br33800(k,2:4);
        br33600_br33800(:,8)=dist33600(k,25);
    end

    k=find(dist33600(:,26)<=36);
    if length(k)~=0;
        br33600_br34000(:,1)=dist33600(k,1);
        br33600_br34000(:,2:4)=br33600(k,2:4);
        br33600_br34000(:,5:7)=br34000(k,2:4);
        br33600_br34000(:,8)=dist33600(k,26);
    end
```

```
    k=find(dist33600(:,27)<=36);
    if length(k)~=0;
        br33600_br34200(:,1)=dist33600(k,1);
        br33600_br34200(:,2:4)=br33600(k,2:4);
        br33600_br34200(:,5:7)=br34200(k,2:4);
        br33600_br34200(:,8)=dist33600(k,27);
    end

    k=find(dist33600(:,28)<=36);
    if length(k)~=0;
        br33600_br34300(:,1)=dist33600(k,1);
        br33600_br34300(:,2:4)=br33600(k,2:4);
        br33600_br34300(:,5:7)=br34300(k,2:4);
        br33600_br34300(:,8)=dist33600(k,28);
    end

    k=find(dist33600(:,29)<=36);
    if length(k)~=0;
        br33600_br34600(:,1)=dist33600(k,1);
        br33600_br34600(:,2:4)=br33600(k,2:4);
        br33600_br34600(:,5:7)=br34600(k,2:4);
        br33600_br34600(:,8)=dist33600(k,29);
    end

    k=find(dist33600(:,30)<=36);
    if length(k)~=0;
        br33600_br34800(:,1)=dist33600(k,1);
        br33600_br34800(:,2:4)=br33600(k,2:4);
        br33600_br34800(:,5:7)=br34800(k,2:4);
        br33600_br34800(:,8)=dist33600(k,30);
    end

    k=find(dist33600(:,31)<=36);
    if length(k)~=0;
        br33600_br34900(:,1)=dist33600(k,1);
        br33600_br34900(:,2:4)=br33600(k,2:4);
        br33600_br34900(:,5:7)=br34900(k,2:4);
        br33600_br34900(:,8)=dist33600(k,31);
    end

    k=find(dist33600(:,32)<=36);
    if length(k)~=0;
        br33600_br35000(:,1)=dist33600(k,1);
        br33600_br35000(:,2:4)=br33600(k,2:4);
        br33600_br35000(:,5:7)=br35000(k,2:4);
        br33600_br35000(:,8)=dist33600(k,32);
    end
end
```

```
if isempty(dist33700);
else
   k=find(dist33700(:,25)<=36);
   if length(k)~=0;
      br33700_br33800(:,1)=dist33700(k,1);
      br33700_br33800(:,2:4)=br33700(k,2:4);
      br33700_br33800(:,5:7)=br33800(k,2:4);
      br33700_br33800(:,8)=dist33700(k,25);
   end

   k=find(dist33700(:,26)<=36);
   if length(k)~=0;
      br33700_br34000(:,1)=dist33700(k,1);
      br33700_br34000(:,2:4)=br33700(k,2:4);
      br33700_br34000(:,5:7)=br34000(k,2:4);
      br33700_br34000(:,8)=dist33700(k,26);
   end

   k=find(dist33700(:,27)<=36);
   if length(k)~=0;
      br33700_br34200(:,1)=dist33700(k,1);
      br33700_br34200(:,2:4)=br33700(k,2:4);
      br33700_br34200(:,5:7)=br34200(k,2:4);
      br33700_br34200(:,8)=dist33700(k,27);
   end

   k=find(dist33700(:,28)<=36);
   if length(k)~=0;
      br33700_br34300(:,1)=dist33700(k,1);
      br33700_br34300(:,2:4)=br33700(k,2:4);
      br33700_br34300(:,5:7)=br34300(k,2:4);
      br33700_br34300(:,8)=dist33700(k,28);
   end

   k=find(dist33700(:,29)<=36);
   if length(k)~=0;
      br33700_br34600(:,1)=dist33700(k,1);
      br33700_br34600(:,2:4)=br33700(k,2:4);
      br33700_br34600(:,5:7)=br34600(k,2:4);
      br33700_br34600(:,8)=dist33700(k,29);
   end

   k=find(dist33700(:,30)<=36);
   if length(k)~=0;
      br33700_br34800(:,1)=dist33700(k,1);
      br33700_br34800(:,2:4)=br33700(k,2:4);
      br33700_br34800(:,5:7)=br34800(k,2:4);
      br33700_br34800(:,8)=dist33700(k,30);
   end
```

```
    k=find(dist33700(:,31)<=36);
    if length(k)~=0;
        br33700_br34900(:,1)=dist33700(k,1);
        br33700_br34900(:,2:4)=br33700(k,2:4);
        br33700_br34900(:,5:7)=br34900(k,2:4);
        br33700_br34900(:,8)=dist33700(k,31);
    end

    k=find(dist33700(:,32)<=36);
    if length(k)~=0;
        br33700_br35000(:,1)=dist33700(k,1);
        br33700_br35000(:,2:4)=br33700(k,2:4);
        br33700_br35000(:,5:7)=br35000(k,2:4);
        br33700_br35000(:,8)=dist33700(k,32);
    end
end

if isempty(dist33800);
else
    k=find(dist33800(:,26)<=36);
    if length(k)~=0;
        br33800_br34000(:,1)=dist33800(k,1);
        br33800_br34000(:,2:4)=br33800(k,2:4);
        br33800_br34000(:,5:7)=br34000(k,2:4);
        br33800_br34000(:,8)=dist33800(k,26);
    end

    k=find(dist33800(:,27)<=36);
    if length(k)~=0;
        br33800_br34200(:,1)=dist33800(k,1);
        br33800_br34200(:,2:4)=br33800(k,2:4);
        br33800_br34200(:,5:7)=br34200(k,2:4);
        br33800_br34200(:,8)=dist33800(k,27);
    end

    k=find(dist33800(:,28)<=36);
    if length(k)~=0;
        br33800_br34300(:,1)=dist33800(k,1);
        br33800_br34300(:,2:4)=br33800(k,2:4);
        br33800_br34300(:,5:7)=br34300(k,2:4);
        br33800_br34300(:,8)=dist33800(k,28);
    end

    k=find(dist33800(:,29)<=36);
    if length(k)~=0;
        br33800_br34600(:,1)=dist33800(k,1);
        br33800_br34600(:,2:4)=br33800(k,2:4);
        br33800_br34600(:,5:7)=br34600(k,2:4);
        br33800_br34600(:,8)=dist33800(k,29);
    end
```

```
    k=find(dist33800(:,30)<=36);
    if length(k)~=0;
        br33800_br34800(:,1)=dist33800(k,1);
        br33800_br34800(:,2:4)=br33800(k,2:4);
        br33800_br34800(:,5:7)=br34800(k,2:4);
        br33800_br34800(:,8)=dist33800(k,30);
    end

    k=find(dist33800(:,31)<=36);
    if length(k)~=0;
        br33800_br34900(:,1)=dist33800(k,1);
        br33800_br34900(:,2:4)=br33800(k,2:4);
        br33800_br34900(:,5:7)=br34900(k,2:4);
        br33800_br34900(:,8)=dist33800(k,31);
    end

    k=find(dist33800(:,32)<=36);
    if length(k)~=0;
        br33800_br35000(:,1)=dist33800(k,1);
        br33800_br35000(:,2:4)=br33800(k,2:4);
        br33800_br35000(:,5:7)=br35000(k,2:4);
        br33800_br35000(:,8)=dist33800(k,32);
    end
end

if isempty(dist34000);
else
    k=find(dist34000(:,27)<=36);
    if length(k)~=0;
        br34000_br34200(:,1)=dist34000(k,1);
        br34000_br34200(:,2:4)=br34000(k,2:4);
        br34000_br34200(:,5:7)=br34200(k,2:4);
        br34000_br34200(:,8)=dist34000(k,27);
    end

    k=find(dist34000(:,28)<=36);
    if length(k)~=0;
        br34000_br34300(:,1)=dist34000(k,1);
        br34000_br34300(:,2:4)=br34000(k,2:4);
        br34000_br34300(:,5:7)=br34300(k,2:4);
        br34000_br34300(:,8)=dist34000(k,28);
    end

    k=find(dist34000(:,29)<=36);
    if length(k)~=0;
        br34000_br34600(:,1)=dist34000(k,1);
        br34000_br34600(:,2:4)=br34000(k,2:4);
        br34000_br34600(:,5:7)=br34600(k,2:4);
        br34000_br34600(:,8)=dist34000(k,29);
```

```
    end

    k=find(dist34000(:,30)<=36);
    if length(k)~=0;
        br34000_br34800(:,1)=dist34000(k,1);
        br34000_br34800(:,2:4)=br34000(k,2:4);
        br34000_br34800(:,5:7)=br34800(k,2:4);
        br34000_br34800(:,8)=dist34000(k,30);
    end

    k=find(dist34000(:,31)<=36);
    if length(k)~=0;
        br34000_br34900(:,1)=dist34000(k,1);
        br34000_br34900(:,2:4)=br34000(k,2:4);
        br34000_br34900(:,5:7)=br34900(k,2:4);
        br34000_br34900(:,8)=dist34000(k,31);
    end

    k=find(dist34000(:,32)<=36);
    if length(k)~=0;
        br34000_br35000(:,1)=dist34000(k,1);
        br34000_br35000(:,2:4)=br34000(k,2:4);
        br34000_br35000(:,5:7)=br35000(k,2:4);
        br34000_br35000(:,8)=dist34000(k,32);
    end
end

if isempty(dist34200);
else
    k=find(dist34200(:,28)<=36);
    if length(k)~=0;
        br34200_br34300(:,1)=dist34200(k,1);
        br34200_br34300(:,2:4)=br34200(k,2:4);
        br34200_br34300(:,5:7)=br34300(k,2:4);
        br34200_br34300(:,8)=dist34200(k,28);
    end

    k=find(dist34200(:,29)<=36);
    if length(k)~=0;
        br34200_br34600(:,1)=dist34200(k,1);
        br34200_br34600(:,2:4)=br34200(k,2:4);
        br34200_br34600(:,5:7)=br34600(k,2:4);
        br34200_br34600(:,8)=dist34200(k,29);
    end

    k=find(dist34200(:,30)<=36);
    if length(k)~=0;
        br34200_br34800(:,1)=dist34200(k,1);
        br34200_br34800(:,2:4)=br34200(k,2:4);
        br34200_br34800(:,5:7)=br34800(k,2:4);
```

```
        br34200_br34800(:,8)=dist34200(k,30);
    end

    k=find(dist34200(:,31)<=36);
    if length(k)~=0;
        br34200_br34900(:,1)=dist34200(k,1);
        br34200_br34900(:,2:4)=br34200(k,2:4);
        br34200_br34900(:,5:7)=br34900(k,2:4);
        br34200_br34900(:,8)=dist34200(k,31);
    end

    k=find(dist34200(:,32)<=36);
    if length(k)~=0;
        br34200_br35000(:,1)=dist34200(k,1);
        br34200_br35000(:,2:4)=br34200(k,2:4);
        br34200_br35000(:,5:7)=br35000(k,2:4);
        br34200_br35000(:,8)=dist34200(k,32);
    end
end

if isempty(dist34300);
else
    k=find(dist34300(:,29)<=36);
    if length(k)~=0;
        br34300_br34600(:,1)=dist34300(k,1);
        br34300_br34600(:,2:4)=br34300(k,2:4);
        br34300_br34600(:,5:7)=br34600(k,2:4);
        br34300_br34600(:,8)=dist34300(k,29);
    end

    k=find(dist34300(:,30)<=36);
    if length(k)~=0;
        br34300_br34800(:,1)=dist34300(k,1);
        br34300_br34800(:,2:4)=br34300(k,2:4);
        br34300_br34800(:,5:7)=br34800(k,2:4);
        br34300_br34800(:,8)=dist34300(k,30);
    end

    k=find(dist34300(:,31)<=36);
    if length(k)~=0;
        br34300_br34900(:,1)=dist34300(k,1);
        br34300_br34900(:,2:4)=br34300(k,2:4);
        br34300_br34900(:,5:7)=br34900(k,2:4);
        br34300_br34900(:,8)=dist34300(k,31);
    end

    k=find(dist34300(:,32)<=36);
    if length(k)~=0;
        br34300_br35000(:,1)=dist34300(k,1);
        br34300_br35000(:,2:4)=br34300(k,2:4);
```

```
      br34300_br35000(:,5:7)=br35000(k,2:4);
      br34300_br35000(:,8)=dist34300(k,32);
   end
end

if isempty(dist34600);
else
   k=find(dist34600(:,30)<=36);
   if length(k)~=0;
      br34600_br34800(:,1)=dist34600(k,1);
      br34600_br34800(:,2:4)=br34600(k,2:4);
      br34600_br34800(:,5:7)=br34800(k,2:4);
      br34600_br34800(:,8)=dist34600(k,30);
   end

   k=find(dist34600(:,31)<=36);
   if length(k)~=0;
      br34600_br34900(:,1)=dist34600(k,1);
      br34600_br34900(:,2:4)=br34600(k,2:4);
      br34600_br34900(:,5:7)=br34900(k,2:4);
      br34600_br34900(:,8)=dist34600(k,31);
   end

   k=find(dist34600(:,32)<=36);
   if length(k)~=0;
      br34600_br35000(:,1)=dist34600(k,1);
      br34600_br35000(:,2:4)=br34600(k,2:4);
      br34600_br35000(:,5:7)=br35000(k,2:4);
      br34600_br35000(:,8)=dist34600(k,32);
   end
end

if isempty(dist34800);
else
   k=find(dist34800(:,31)<=36);
   if length(k)~=0;
      br34800_br34900(:,1)=dist34800(k,1);
      br34800_br34900(:,2:4)=br34800(k,2:4);
      br34800_br34900(:,5:7)=br34900(k,2:4);
      br34800_br34900(:,8)=dist34800(k,31);
   end

   k=find(dist34800(:,32)<=36);
   if length(k)~=0;
      br34800_br35000(:,1)=dist34800(k,1);
      br34800_br35000(:,2:4)=br34800(k,2:4);
      br34800_br35000(:,5:7)=br35000(k,2:4);
      br34800_br35000(:,8)=dist34800(k,32);
   end
end
```

```
if isempty(dist34900);
else
    k=find(dist34900(:,32)<=36);
    if length(k)~=0;
        br34900_br35000(:,1)=dist34900(k,1);
        br34900_br35000(:,2:4)=br34900(k,2:4);
        br34900_br35000(:,5:7)=br35000(k,2:4);
        br34900_br35000(:,8)=dist34900(k,32);
    end
end
```

schoolingdistances.m

```
clear br* data s* h* p*

data=who;

distances=(2:5:86397)';
for a=1:length(data)
   eval(['datafile=' char(data(a)) ';'])
   distances=[distances datafile(:,a+1:end)];
end
clear datafile data a

temp=[];
for b=1:17280
   k=isnan(distances(b,:));
   j=find(k==1);
   if length(j)<496;
      temp=[temp;distances(b,:)];
   end
end
distances=temp;
clear temp j k b

for c=2:497
   k=find(distances(:,c)>36);
   distances(k,c)=NaN;
end
clear k c

[col,rows]=size(distances);
temp=[];
for b=1:col
   k=isnan(distances(b,:));
   j=find(k==1);
   if length(j)<496;
      temp=[temp;distances(b,:)];
   end
end
distances=temp;
clear temp j k b

[col,rows]=size(distances);
distmean=[];
for d=1:col
   k=isnan(distances(d,2:end));
   n=find(k==0);
   distmean(d,1)=distances(d,1);
   distmean(d,2)=length(n);
   if length(n)==1
```

```
    distmean(d,3)=distances(d,n+1);
    else
    distmean(d,3)=nanmean(distances(d,2:end));
    end
end
clear col rows d k n
```

schoolperiods36.m

```
k=find(day>36);
noschoolday=day(k);
k=find(night>36);
noschoolnight=night(k);
k=find(dawn>36);
noschooldawn=dawn(k);
k=find(dusk>36);
noschooldusk=dusk(k);

k=find(day<=36);
schoolday=day(k);
k=find(night<=36);
schoolnight=night(k);
k=find(dawn<=36);
schooldawn=dawn(k);
k=find(dusk<=36);
schooldusk=dusk(k);

k=find(day(:,1)<=36);
if isempty(k)
    br30100(:,1)=NaN;
else
    br30100(:,1)=length(k);
end
k=find(night(:,1)<=36);
if isempty(k)
    br30100(:,2)=NaN;
else
    br30100(:,2)=length(k);
end
k=find(dawn(:,1)<=36);
if isempty(k)
    br30100(:,3)=NaN;
else
    br30100(:,3)=length(k);
end
k=find(dusk(:,1)<=36);
if isempty(k)
    br30100(:,4)=NaN;
else
    br30100(:,4)=length(k);
end
```

```
k=find(day(:,2)<=36);
if isempty(k)
   br30200(:,1)=NaN;
else
   br30200(:,1)=length(k);
end
k=find(night(:,2)<=36);
if isempty(k)
   br30200(:,2)=NaN;
else
   br30200(:,2)=length(k);
end
k=find(dawn(:,2)<=36);
if isempty(k)
   br30200(:,3)=NaN;
else
   br30200(:,3)=length(k);
end
k=find(dusk(:,2)<=36);
if isempty(k)
   br30200(:,4)=NaN;
else
   br30200(:,4)=length(k);
end

k=find(day(:,3)<=36);
if isempty(k)
   br30500(:,1)=NaN;
else
   br30500(:,1)=length(k);
end
k=find(night(:,3)<=36);
if isempty(k)
   br30500(:,2)=NaN;
else
   br30500(:,2)=length(k);
end
k=find(dawn(:,3)<=36);
if isempty(k)
   br30500(:,3)=NaN;
else
   br30500(:,3)=length(k);
end
k=find(dusk(:,3)<=36);
if isempty(k)
   br30500(:,4)=NaN;
else
   br30500(:,4)=length(k);
end
```

```
k=find(day(:,4)<=36);
if isempty(k)
   br30600(:,1)=NaN;
else
   br30600(:,1)=length(k);
end

k=find(night(:,4)<=36);
if isempty(k)
   br30600(:,2)=NaN;
else
   br30600(:,2)=length(k);
end
k=find(dawn(:,4)<=36);
if isempty(k)
   br30600(:,3)=NaN;
else
   br30600(:,3)=length(k);
end
k=find(dusk(:,4)<=36);
if isempty(k)
   br30600(:,4)=NaN;
else
   br30600(:,4)=length(k);
end

k=find(day(:,5)<=36);
if isempty(k)
   br30800(:,1)=NaN;
else
   br30800(:,1)=length(k);
end
k=find(night(:,5)<=36);
if isempty(k)
   br30800(:,2)=NaN;
else
   br30800(:,2)=length(k);
end
k=find(dawn(:,5)<=36);
if isempty(k)
   br30800(:,3)=NaN;
else
   br30800(:,3)=length(k);
end
k=find(dusk(:,5)<=36);
if isempty(k)
   br30800(:,4)=NaN;
else
   br30800(:,4)=length(k);
```

```
end

k=find(day(:,6)<=36);
if isempty(k)
   br31200(:,1)=NaN;
else
   br31200(:,1)=length(k);
end
k=find(night(:,6)<=36);
if isempty(k)
   br31200(:,2)=NaN;
else
   br31200(:,2)=length(k);
end
k=find(dawn(:,6)<=36);
if isempty(k)
   br31200(:,3)=NaN;
else
   br31200(:,3)=length(k);
end
k=find(dusk(:,6)<=36);
if isempty(k)
   br31200(:,4)=NaN;
else
   br31200(:,4)=length(k);
end

k=find(day(:,7)<=36);
if isempty(k)
   br31300(:,1)=NaN;
else
   br31300(:,1)=length(k);
end
k=find(night(:,7)<=36);
if isempty(k)
   br31300(:,2)=NaN;
else
   br31300(:,2)=length(k);
end
k=find(dawn(:,7)<=36);
if isempty(k)
   br31300(:,3)=NaN;
else
   br31300(:,3)=length(k);
end
k=find(dusk(:,7)<=36);
if isempty(k)
   br31300(:,4)=NaN;
else
   br31300(:,4)=length(k);
```

```
end

k=find(day(:,8)<=36);
if isempty(k)
   br31400(:,1)=NaN;
else
   br31400(:,1)=length(k);
end
k=find(night(:,8)<=36);
if isempty(k)
   br31400(:,2)=NaN;
else
   br31400(:,2)=length(k);
end
k=find(dawn(:,8)<=36);
if isempty(k)
   br31400(:,3)=NaN;
else
   br31400(:,3)=length(k);
end
k=find(dusk(:,8)<=36);
if isempty(k)
   br31400(:,4)=NaN;
else
   br31400(:,4)=length(k);
end

k=find(day(:,9)<=36);
if isempty(k)
   br31500(:,1)=NaN;
else
   br31500(:,1)=length(k);
end
k=find(night(:,9)<=36);
if isempty(k)
   br31500(:,2)=NaN;
else
   br31500(:,2)=length(k);
end
k=find(dawn(:,9)<=36);
if isempty(k)
   br31500(:,3)=NaN;
else
   br31500(:,3)=length(k);
end
k=find(dusk(:,9)<=36);
if isempty(k)
   br31500(:,4)=NaN;
else
   br31500(:,4)=length(k);
```

```
end

k=find(day(:,10)<=36);
if isempty(k)
   br31600(:,1)=NaN;
else
   br31600(:,1)=length(k);
end
k=find(night(:,10)<=36);
if isempty(k)
   br31600(:,2)=NaN;
else
   br31600(:,2)=length(k);
end
k=find(dawn(:,10)<=36);
if isempty(k)
   br31600(:,3)=NaN;
else
   br31600(:,3)=length(k);
end
k=find(dusk(:,10)<=36);
if isempty(k)
   br31600(:,4)=NaN;
else
   br31600(:,4)=length(k);
end

k=find(day(:,11)<=36);
if isempty(k)
   br31800(:,1)=NaN;
else
   br31800(:,1)=length(k);
end
k=find(night(:,11)<=36);
if isempty(k)
   br31800(:,2)=NaN;
else
   br31800(:,2)=length(k);
end
k=find(dawn(:,11)<=36);
if isempty(k)
   br31800(:,3)=NaN;
else
   br31800(:,3)=length(k);
end
k=find(dusk(:,11)<=36);
if isempty(k)
   br31800(:,4)=NaN;
else
   br31800(:,4)=length(k);
```

```
end

k=find(day(:,12)<=36);
if isempty(k)
   br32100(:,1)=NaN;
else
   br32100(:,1)=length(k);
end
k=find(night(:,12)<=36);
if isempty(k)
   br32100(:,2)=NaN;
else
   br32100(:,2)=length(k);
end
k=find(dawn(:,12)<=36);
if isempty(k)
   br32100(:,3)=NaN;
else
   br32100(:,3)=length(k);
end
k=find(dusk(:,12)<=36);
if isempty(k)
   br32100(:,4)=NaN;
else
   br32100(:,4)=length(k);
end

k=find(day(:,13)<=36);
if isempty(k)
   br32300(:,1)=NaN;
else
   br32300(:,1)=length(k);
end

k=find(night(:,13)<=36);
if isempty(k)
   br32300(:,2)=NaN;
else
   br32300(:,2)=length(k);
end
k=find(dawn(:,13)<=36);
if isempty(k)
   br32300(:,3)=NaN;
else
   br32300(:,3)=length(k);
end
k=find(dusk(:,13)<=36);
if isempty(k)
   br32300(:,4)=NaN;
else
```

```
    br32300(:,4)=length(k);
end

k=find(day(:,14)<=36);
if isempty(k)
    br32400(:,1)=NaN;
else
    br32400(:,1)=length(k);
end
k=find(night(:,14)<=36);
if isempty(k)
    br32400(:,2)=NaN;
else
    br32400(:,2)=length(k);
end
k=find(dawn(:,14)<=36);
if isempty(k)
    br32400(:,3)=NaN;
else
    br32400(:,3)=length(k);
end
k=find(dusk(:,14)<=36);
if isempty(k)
    br32400(:,4)=NaN;
else
    br32400(:,4)=length(k);
end

k=find(day(:,15)<=36);
if isempty(k)
    br32500(:,1)=NaN;
else
    br32500(:,1)=length(k);
end
k=find(night(:,15)<=36);
if isempty(k)
    br32500(:,2)=NaN;
else
    br32500(:,2)=length(k);
end
k=find(dawn(:,15)<=36);
if isempty(k)
    br32500(:,3)=NaN;
else
    br32500(:,3)=length(k);
end
k=find(dusk(:,15)<=36);
if isempty(k)
    br32500(:,4)=NaN;
else
```

```
    br32500(:,4)=length(k);
end

k=find(day(:,16)<=36);
if isempty(k)
    br32700(:,1)=NaN;
else
    br32700(:,1)=length(k);
end
k=find(night(:,16)<=36);
if isempty(k)
    br32700(:,2)=NaN;
else
    br32700(:,2)=length(k);
end
k=find(dawn(:,16)<=36);
if isempty(k)
    br32700(:,3)=NaN;
else
    br32700(:,3)=length(k);
end
k=find(dusk(:,16)<=36);
if isempty(k)
    br32700(:,4)=NaN;
else
    br32700(:,4)=length(k);
end

k=find(day(:,17)<=36);
if isempty(k)
    br32900(:,1)=NaN;
else
    br32900(:,1)=length(k);
end
k=find(night(:,17)<=36);
if isempty(k)
    br32900(:,2)=NaN;
else
    br32900(:,2)=length(k);
end
k=find(dawn(:,17)<=36);
if isempty(k)
    br32900(:,3)=NaN;
else
    br32900(:,3)=length(k);
end
k=find(dusk(:,17)<=36);
if isempty(k)
    br32900(:,4)=NaN;
else
```

```
    br32900(:,4)=length(k);
end

k=find(day(:,18)<=36);
if isempty(k)
    br33000(:,1)=NaN;
else
    br33000(:,1)=length(k);
end
k=find(night(:,18)<=36);
if isempty(k)
    br33000(:,2)=NaN;
else
    br33000(:,2)=length(k);
end
k=find(dawn(:,18)<=36);
if isempty(k)
    br33000(:,3)=NaN;
else
    br33000(:,3)=length(k);
end
k=find(dusk(:,18)<=36);
if isempty(k)
    br33000(:,4)=NaN;
else
    br33000(:,4)=length(k);
end

k=find(day(:,19)<=36);
if isempty(k)
    br33200(:,1)=NaN;
else
    br33200(:,1)=length(k);
end
k=find(night(:,19)<=36);
if isempty(k)
    br33200(:,2)=NaN;
else
    br33200(:,2)=length(k);
end
k=find(dawn(:,19)<=36);
if isempty(k)
    br33200(:,3)=NaN;
else
    br33200(:,3)=length(k);
end
k=find(dusk(:,19)<=36);
if isempty(k)
    br33200(:,4)=NaN;
else
```

```
    br33200(:,4)=length(k);
end

k=find(day(:,20)<=36);
if isempty(k)
    br33300(:,1)=NaN;
else
    br33300(:,1)=length(k);
end
k=find(night(:,20)<=36);
if isempty(k)
    br33300(:,2)=NaN;
else
    br33300(:,2)=length(k);
end
k=find(dawn(:,20)<=36);
if isempty(k)
    br33300(:,3)=NaN;
else
    br33300(:,3)=length(k);
end
k=find(dusk(:,20)<=36);
if isempty(k)
    br33300(:,4)=NaN;
else
    br33300(:,4)=length(k);
end

k=find(day(:,21)<=36);
if isempty(k)
    br33500(:,1)=NaN;
else
    br33500(:,1)=length(k);
end

k=find(night(:,21)<=36);
if isempty(k)
    br33500(:,2)=NaN;
else
    br33500(:,2)=length(k);
end
k=find(dawn(:,21)<=36);
if isempty(k)
    br33500(:,3)=NaN;
else
    br33500(:,3)=length(k);
end
k=find(dusk(:,21)<=36);
if isempty(k)
    br33500(:,4)=NaN;
```

```
else
    br33500(:,4)=length(k);
end

k=find(day(:,22)<=36);
if isempty(k)
    br33600(:,1)=NaN;
else
    br33600(:,1)=length(k);
end

k=find(night(:,22)<=36);
if isempty(k)
    br33600(:,2)=NaN;
else
    br33600(:,2)=length(k);
end
k=find(dawn(:,22)<=36);
if isempty(k)
    br33600(:,3)=NaN;
else
    br33600(:,3)=length(k);
end
k=find(dusk(:,22)<=36);
if isempty(k)
    br33600(:,4)=NaN;
else
    br33600(:,4)=length(k);
end

k=find(day(:,23)<=36);
if isempty(k)
    br33700(:,1)=NaN;
else
    br33700(:,1)=length(k);
end
k=find(night(:,23)<=36);
if isempty(k)
    br33700(:,2)=NaN;
else
    br33700(:,2)=length(k);
end
k=find(dawn(:,23)<=36);
if isempty(k)
    br33700(:,3)=NaN;
else
    br33700(:,3)=length(k);
end
k=find(dusk(:,23)<=36);
if isempty(k)
```

```
   br33700(:,4)=NaN;
else
   br33700(:,4)=length(k);
end

k=find(day(:,24)<=36);
if isempty(k)
   br33800(:,1)=NaN;
else
   br33800(:,1)=length(k);
end
k=find(night(:,24)<=36);
if isempty(k)
   br33800(:,2)=NaN;
else
   br33800(:,2)=length(k);
end
k=find(dawn(:,24)<=36);
if isempty(k)
   br33800(:,3)=NaN;
else
   br33800(:,3)=length(k);
end
k=find(dusk(:,24)<=36);
if isempty(k)
   br33800(:,4)=NaN;
else
   br33800(:,4)=length(k);
end

k=find(day(:,25)<=36);
if isempty(k)
   br34000(:,1)=NaN;
else
   br34000(:,1)=length(k);
end
k=find(night(:,25)<=36);
if isempty(k)
   br34000(:,2)=NaN;
else
   br34000(:,2)=length(k);
end
k=find(dawn(:,25)<=36);
if isempty(k)
   br34000(:,3)=NaN;
else
   br34000(:,3)=length(k);
end
k=find(dusk(:,25)<=36);
if isempty(k)
```

```
    br34000(:,4)=NaN;
else
    br34000(:,4)=length(k);
end

k=find(day(:,26)<=36);
if isempty(k)
    br34200(:,1)=NaN;
else
    br34200(:,1)=length(k);
end
k=find(night(:,26)<=36);
if isempty(k)
    br34200(:,2)=NaN;
else
    br34200(:,2)=length(k);
end
k=find(dawn(:,26)<=36);
if isempty(k)
    br34200(:,3)=NaN;
else
    br34200(:,3)=length(k);
end
k=find(dusk(:,26)<=36);
if isempty(k)
    br34200(:,4)=NaN;
else
    br34200(:,4)=length(k);
end

k=find(day(:,27)<=36);
if isempty(k)
    br34300(:,1)=NaN;
else
    br34300(:,1)=length(k);
end
k=find(night(:,27)<=36);
if isempty(k)
    br34300(:,2)=NaN;
else
    br34300(:,2)=length(k);
end
k=find(dawn(:,27)<=36);
if isempty(k)
    br34300(:,3)=NaN;
else
    br34300(:,3)=length(k);
end
k=find(dusk(:,27)<=36);
if isempty(k)
```

```
    br34300(:,4)=NaN;
else
    br34300(:,4)=length(k);
end

k=find(day(:,28)<=36);
if isempty(k)
    br34600(:,1)=NaN;
else
    br34600(:,1)=length(k);
end
k=find(night(:,28)<=36);
if isempty(k)
    br34600(:,2)=NaN;
else
    br34600(:,2)=length(k);
end
k=find(dawn(:,28)<=36);
if isempty(k)
    br34600(:,3)=NaN;
else
    br34600(:,3)=length(k);
end
k=find(dusk(:,28)<=36);
if isempty(k)
    br34600(:,4)=NaN;
else
    br34600(:,4)=length(k);
end

k=find(day(:,29)<=36);
if isempty(k)
    br34800(:,1)=NaN;
else
    br34800(:,1)=length(k);
end
k=find(night(:,29)<=36);
if isempty(k)
    br34800(:,2)=NaN;
else
    br34800(:,2)=length(k);
end
k=find(dawn(:,29)<=36);
if isempty(k)
    br34800(:,3)=NaN;
else
    br34800(:,3)=length(k);
end
k=find(dusk(:,29)<=36);
if isempty(k)
```

```
   br34800(:,4)=NaN;
else
   br34800(:,4)=length(k);
end

k=find(day(:,30)<=36);
if isempty(k)
   br34900(:,1)=NaN;
else
   br34900(:,1)=length(k);
end
k=find(night(:,30)<=36);
if isempty(k)
   br34900(:,2)=NaN;
else
   br34900(:,2)=length(k);
end
k=find(dawn(:,30)<=36);
if isempty(k)
   br34900(:,3)=NaN;
else
   br34900(:,3)=length(k);
end
k=find(dusk(:,30)<=36);
if isempty(k)
   br34900(:,4)=NaN;
else
   br34900(:,4)=length(k);
end

k=find(day(:,31)<=36);
if isempty(k)
   br35000(:,1)=NaN;
else
   br35000(:,1)=length(k);
end
k=find(night(:,31)<=36);
if isempty(k)
   br35000(:,2)=NaN;
else
   br35000(:,2)=length(k);
end
k=find(dawn(:,31)<=36);
if isempty(k)
   br35000(:,3)=NaN;
else
   br35000(:,3)=length(k);
end
k=find(dusk(:,31)<=36);
if isempty(k)
```

```
    br35000(:,4)=NaN;
else
    br35000(:,4)=length(k);
end

clear k
```

schoolx2.m

```
%This routine calculates the chi-square value for the schooling data from
%the ST151 data.  The data has 22 columns and four rows.  The rows are day,
%night, dawn, and dusk.  The columns are the other tagged fish.  The data
%represents the number of times a fish comes within 5m of the target fish.

%Calculate the summation of the rows and the total of the rows
coltotal(1,1)=nansum(data(:,1));
coltotal(2,1)=nansum(data(:,2));
total=sum(coltotal(:,1));

%Calculate the nansummation of the columns
rowtotal(1,1)=nansum(data(1,:));
rowtotal(1,2)=nansum(data(2,:));
rowtotal(1,3)=nansum(data(3,:));
rowtotal(1,4)=nansum(data(4,:));
rowtotal(1,5)=nansum(data(5,:));
rowtotal(1,6)=nansum(data(6,:));
rowtotal(1,7)=nansum(data(7,:));
rowtotal(1,8)=nansum(data(8,:));
rowtotal(1,9)=nansum(data(9,:));
rowtotal(1,10)=nansum(data(10,:));
rowtotal(1,11)=nansum(data(11,:));
rowtotal(1,12)=nansum(data(12,:));
rowtotal(1,13)=nansum(data(13,:));
rowtotal(1,14)=nansum(data(14,:));
rowtotal(1,15)=nansum(data(15,:));
rowtotal(1,16)=nansum(data(16,:));
rowtotal(1,17)=nansum(data(17,:));
rowtotal(1,18)=nansum(data(18,:));
rowtotal(1,19)=nansum(data(19,:));
rowtotal(1,20)=nansum(data(20,:));
rowtotal(1,21)=nansum(data(21,:));
rowtotal(1,22)=nansum(data(22,:));
rowtotal(1,23)=nansum(data(23,:));
rowtotal(1,24)=nansum(data(24,:));
rowtotal(1,25)=nansum(data(25,:));
rowtotal(1,26)=nansum(data(26,:));
rowtotal(1,27)=nansum(data(27,:));
rowtotal(1,28)=nansum(data(28,:));
rowtotal(1,29)=nansum(data(29,:));
rowtotal(1,30)=nansum(data(30,:));
rowtotal(1,31)=nansum(data(31,:));
rowtotal(1,32)=nansum(data(32,:));
rowtotal=rowtotal';

%Calculate the expected values, based on equal probabilities of occurrence
expected(1,1)=(rowtotal(1,1)/total)*coltotal(1,1);
expected(1,2)=(rowtotal(1,2)/total)*coltotal(1,1);
```

```
expected(1,3)=(rowtotal(1,3)/total)*coltotal(1,1);
expected(1,4)=(rowtotal(1,4)/total)*coltotal(1,1);
expected(1,5)=(rowtotal(1,5)/total)*coltotal(1,1);
expected(1,6)=(rowtotal(1,6)/total)*coltotal(1,1);
expected(1,7)=(rowtotal(1,7)/total)*coltotal(1,1);
expected(1,8)=(rowtotal(1,8)/total)*coltotal(1,1);
expected(1,9)=(rowtotal(1,9)/total)*coltotal(1,1);
expected(1,10)=(rowtotal(1,10)/total)*coltotal(1,1);
expected(1,11)=(rowtotal(1,11)/total)*coltotal(1,1);
expected(1,12)=(rowtotal(1,12)/total)*coltotal(1,1);
expected(1,13)=(rowtotal(1,13)/total)*coltotal(1,1);
expected(1,14)=(rowtotal(1,14)/total)*coltotal(1,1);
expected(1,15)=(rowtotal(1,15)/total)*coltotal(1,1);
expected(1,16)=(rowtotal(1,16)/total)*coltotal(1,1);
expected(1,17)=(rowtotal(1,17)/total)*coltotal(1,1);
expected(1,18)=(rowtotal(1,18)/total)*coltotal(1,1);
expected(1,19)=(rowtotal(1,19)/total)*coltotal(1,1);
expected(1,20)=(rowtotal(1,20)/total)*coltotal(1,1);
expected(1,21)=(rowtotal(1,21)/total)*coltotal(1,1);
expected(1,22)=(rowtotal(1,22)/total)*coltotal(1,1);
expected(1,23)=(rowtotal(1,23)/total)*coltotal(1,1);
expected(1,24)=(rowtotal(1,24)/total)*coltotal(1,1);
expected(1,25)=(rowtotal(1,25)/total)*coltotal(1,1);
expected(1,26)=(rowtotal(1,26)/total)*coltotal(1,1);
expected(1,27)=(rowtotal(1,27)/total)*coltotal(1,1);
expected(1,28)=(rowtotal(1,28)/total)*coltotal(1,1);
expected(1,29)=(rowtotal(1,29)/total)*coltotal(1,1);
expected(1,30)=(rowtotal(1,30)/total)*coltotal(1,1);
expected(1,31)=(rowtotal(1,31)/total)*coltotal(1,1);
expected(1,32)=(rowtotal(1,32)/total)*coltotal(1,1);

expected(2,1)=(rowtotal(1,1)/total)*coltotal(2,1);
expected(2,2)=(rowtotal(1,2)/total)*coltotal(2,1);
expected(2,3)=(rowtotal(1,3)/total)*coltotal(2,1);
expected(2,4)=(rowtotal(1,4)/total)*coltotal(2,1);
expected(2,5)=(rowtotal(1,5)/total)*coltotal(2,1);
expected(2,6)=(rowtotal(1,6)/total)*coltotal(2,1);
expected(2,7)=(rowtotal(1,7)/total)*coltotal(2,1);
expected(2,8)=(rowtotal(1,8)/total)*coltotal(2,1);
expected(2,9)=(rowtotal(1,9)/total)*coltotal(2,1);
expected(2,10)=(rowtotal(1,10)/total)*coltotal(2,1);
expected(2,11)=(rowtotal(1,11)/total)*coltotal(2,1);
expected(2,12)=(rowtotal(1,12)/total)*coltotal(2,1);
expected(2,13)=(rowtotal(1,13)/total)*coltotal(2,1);
expected(2,14)=(rowtotal(1,14)/total)*coltotal(2,1);
expected(2,15)=(rowtotal(1,15)/total)*coltotal(2,1);
expected(2,16)=(rowtotal(1,16)/total)*coltotal(2,1);
expected(2,17)=(rowtotal(1,17)/total)*coltotal(2,1);
expected(2,18)=(rowtotal(1,18)/total)*coltotal(2,1);
expected(2,19)=(rowtotal(1,19)/total)*coltotal(2,1);
```

```
expected(2,20)=(rowtotal(1,20)/total)*coltotal(2,1);
expected(2,21)=(rowtotal(1,21)/total)*coltotal(2,1);
expected(2,22)=(rowtotal(1,22)/total)*coltotal(2,1);
expected(2,23)=(rowtotal(1,23)/total)*coltotal(2,1);
expected(2,24)=(rowtotal(1,24)/total)*coltotal(2,1);
expected(2,25)=(rowtotal(1,25)/total)*coltotal(2,1);
expected(2,26)=(rowtotal(1,26)/total)*coltotal(2,1);
expected(2,27)=(rowtotal(1,27)/total)*coltotal(2,1);
expected(2,28)=(rowtotal(1,28)/total)*coltotal(2,1);
expected(2,29)=(rowtotal(1,29)/total)*coltotal(2,1);
expected(2,30)=(rowtotal(1,30)/total)*coltotal(2,1);
expected(2,31)=(rowtotal(1,31)/total)*coltotal(2,1);
expected(2,32)=(rowtotal(1,32)/total)*coltotal(2,1);

%Calculate the chi-square value using ((observed-expectedected)^2)/expectedected
and
%then nansumming the values
obsexp(1,1)=((data(1,1)-expected(1,1))^2)/expected(1,1);
obsexp(1,2)=((data(1,2)-expected(1,2))^2)/expected(1,2);
obsexp(1,3)=((data(1,3)-expected(1,3))^2)/expected(1,3);
obsexp(1,4)=((data(1,4)-expected(1,4))^2)/expected(1,4);
obsexp(1,5)=((data(1,5)-expected(1,5))^2)/expected(1,5);
obsexp(1,6)=((data(1,6)-expected(1,6))^2)/expected(1,6);
obsexp(1,7)=((data(1,7)-expected(1,7))^2)/expected(1,7);
obsexp(1,8)=((data(1,8)-expected(1,8))^2)/expected(1,8);
obsexp(1,9)=((data(1,9)-expected(1,9))^2)/expected(1,9);
obsexp(1,10)=((data(1,10)-expected(1,10))^2)/expected(1,10);
obsexp(1,11)=((data(1,11)-expected(1,11))^2)/expected(1,11);
obsexp(1,12)=((data(1,12)-expected(1,12))^2)/expected(1,12);
obsexp(1,13)=((data(1,13)-expected(1,13))^2)/expected(1,13);
obsexp(1,14)=((data(1,14)-expected(1,14))^2)/expected(1,14);
obsexp(1,15)=((data(1,15)-expected(1,15))^2)/expected(1,15);
obsexp(1,16)=((data(1,16)-expected(1,16))^2)/expected(1,16);
obsexp(1,17)=((data(1,17)-expected(1,17))^2)/expected(1,17);
obsexp(1,18)=((data(1,18)-expected(1,18))^2)/expected(1,18);
obsexp(1,19)=((data(1,19)-expected(1,19))^2)/expected(1,19);
obsexp(1,20)=((data(1,20)-expected(1,20))^2)/expected(1,20);
obsexp(1,21)=((data(1,21)-expected(1,21))^2)/expected(1,21);
obsexp(1,22)=((data(1,22)-expected(1,22))^2)/expected(1,22);
obsexp(1,23)=((data(1,23)-expected(1,23))^2)/expected(1,23);
obsexp(1,24)=((data(1,24)-expected(1,24))^2)/expected(1,24);
obsexp(1,25)=((data(1,25)-expected(1,25))^2)/expected(1,25);
obsexp(1,26)=((data(1,26)-expected(1,26))^2)/expected(1,26);
obsexp(1,27)=((data(1,27)-expected(1,27))^2)/expected(1,27);
obsexp(1,28)=((data(1,28)-expected(1,28))^2)/expected(1,28);
obsexp(1,29)=((data(1,29)-expected(1,29))^2)/expected(1,29);
obsexp(1,30)=((data(1,30)-expected(1,30))^2)/expected(1,30);
obsexp(1,31)=((data(1,31)-expected(1,31))^2)/expected(1,31);
obsexp(1,31)=((data(1,32)-expected(1,32))^2)/expected(1,32);
```

```
obsexp(2,1)=((data(2,1)-expected(2,1))^2)/expected(2,1);
obsexp(2,2)=((data(2,2)-expected(2,2))^2)/expected(2,2);
obsexp(2,3)=((data(2,3)-expected(2,3))^2)/expected(2,3);
obsexp(2,4)=((data(2,4)-expected(2,4))^2)/expected(2,4);
obsexp(2,5)=((data(2,5)-expected(2,5))^2)/expected(2,5);
obsexp(2,6)=((data(2,6)-expected(2,6))^2)/expected(2,6);
obsexp(2,7)=((data(2,7)-expected(2,7))^2)/expected(2,7);
obsexp(2,8)=((data(2,8)-expected(2,8))^2)/expected(2,8);
obsexp(2,9)=((data(2,9)-expected(2,9))^2)/expected(2,9);
obsexp(2,10)=((data(2,10)-expected(2,10))^2)/expected(2,10);
obsexp(2,11)=((data(2,11)-expected(2,11))^2)/expected(2,11);
obsexp(2,12)=((data(2,12)-expected(2,12))^2)/expected(2,12);
obsexp(2,13)=((data(2,13)-expected(2,13))^2)/expected(2,13);
obsexp(2,14)=((data(2,14)-expected(2,14))^2)/expected(2,14);
obsexp(2,15)=((data(2,15)-expected(2,15))^2)/expected(2,15);
obsexp(2,16)=((data(2,16)-expected(2,16))^2)/expected(2,16);
obsexp(2,17)=((data(2,17)-expected(2,17))^2)/expected(2,17);
obsexp(2,18)=((data(2,18)-expected(2,18))^2)/expected(2,18);
obsexp(2,19)=((data(2,19)-expected(2,19))^2)/expected(2,19);
obsexp(2,20)=((data(2,20)-expected(2,20))^2)/expected(2,20);
obsexp(2,21)=((data(2,21)-expected(2,21))^2)/expected(2,21);
obsexp(2,22)=((data(2,22)-expected(2,22))^2)/expected(2,22);
obsexp(2,23)=((data(2,23)-expected(2,23))^2)/expected(2,23);
obsexp(2,24)=((data(2,24)-expected(2,24))^2)/expected(2,24);
obsexp(2,25)=((data(2,25)-expected(2,25))^2)/expected(2,25);
obsexp(2,26)=((data(2,26)-expected(2,26))^2)/expected(2,26);
obsexp(2,27)=((data(2,27)-expected(2,27))^2)/expected(2,27);
obsexp(2,28)=((data(2,28)-expected(2,28))^2)/expected(2,28);
obsexp(2,29)=((data(2,29)-expected(2,29))^2)/expected(2,29);
obsexp(2,30)=((data(2,30)-expected(2,30))^2)/expected(2,30);
obsexp(2,31)=((data(2,31)-expected(2,31))^2)/expected(2,31);

temp=nansum(obsexp(:,:));
x2=sum(temp(1,:));

[h,P,ci,STATS]=ttest(rowtotal);

clear rowtotal rowtotal expected obsexp total temp data h ci
```

sigmat.m

```
%Calculates the density of seawater (sigma t) based on temperature and
%salinity
%returns sig=sigmat(s,t) where s,t can be column vectors
%   from page 17, Fofonoff and Millard
%written by Jim Manning

a=[6.536332e-9,-1.120083e-6,1.001685e-4,-9.095290e-3,6.793952e-2,999.842594];
b=[5.3875e-9,-8.2467e-7,7.6438e-5,-4.0899e-3,8.24493e-1];
c=[-1.6546e-6,1.0227e-4,-5.72466e-3];
d=4.8314e-4;
sig=polyval(a,t)+(polyval(b,t)+polyval(c,t).*sqrt(s)+d*s).*s;

clear a b c d
```

swimming.m

```
j=1;
forklength=forklength/1000;

time=data(2:end,1)-data(1:end-1,1);

k=find(time(:,1)>60);
if length(k)>1
   temp=[time(1:k(1),:);NaN];
   temp2=[data(1:k(1),:);ones(1,4)*NaN];
   for c=1:length(k)-1
      temp=[temp;time(k(c)+1:k(c+1),1);NaN];
      temp2=[temp2;data(k(c)+1:k(c+1),1:4);ones(1,4)*NaN];
   end
      temp=[temp;time(k(c+1)+1:end,:)];
      temp2=[temp2;data(k(c+1)+1:end,:)];
else
   temp=time;
   temp2=data;
end

time=temp;
data=temp2;

while j<length(data)
   x1=data(j,2);
   y1=data(j,3);
   z1=data(j,4);

   x2=data(j+1,2);
   y2=data(j+1,3);
   z2=data(j+1,4);

   x=x2-x1;
   y=y2-y1;
   z=z2-z1;

   dist(j,1)=sqrt((x.^2)+(y.^2)+(z.^2));
   j=j+1;
end

r=1;
while r<=length(time)
   speed(r,1)=dist(r,1)/time(r,1);
   r=r+1;
end

bodylengths=speed/forklength;
```

```
clear x* y* z* j m n p r temp k temp2 c
```

timeperiods.m

```
%This routine separates the depth data into 4 discrete time periods -
%night(all data up to one half hour before sunrise and all data after one
%hour after sunset), dawn (the period between one half hour before sunrise
%and one half hour after sunrise), day (the period between one half hour
%after sunrise and one half hour before sunset), dusk (the period between
%one half before sunset and one half hour after sunset).  This routine is only
%valid for the days between 5Aug05 and 26Aug05 in the Gulf of Mexico.


k=find(data(:,1)<218);%find all data for day 217
day217=(data(k,:));%assign data to new variable
data(k,:)=[];%delete data for day 217
k=find(day217(:,1)<217.2019);%find data 1/2 before sunrise
night=day217(k,:);%assign data to new night variable
day217(k,:)=[];%delete night data
k=find(day217(:,1)<217.2435);%find data for dawn period
dawn=day217(k,:);%assign data to new dawn variable
day217(k,:)=[];%delete dawn data
k=find(day217(:,1)<217.7632);%find daytime data
day=day217(k,:);%assign data to new day variable
day217(k,:)=[];%delete daytime data
k=find(day217(:,1)<217.8049);%find data for dusk period
dusk=day217(k,:);%assign data to new dusk variable
day217(k,:)=[];%delete dusk data
night=[night;day217];%concat remaining data onto night variable
clear day217

k=find(data(:,1)<219);
day218=data(k,:);
data(k,:)=[];
k=find(day218(:,1)<218.2049);
night=[night;day218(k,:)];
day218(k,:)=[];
k=find(day218(:,1)<218.2465);
dawn=[dawn;day218(k,:)];
day218(k,:)=[];
k=find(day218(:,1)<218.7625);
day=[day;day218(k,:)];
day218(k,:)=[];
k=find(day218(:,1)<218.8042);
dusk=[dusk;day218(k,:)];
day218(k,:)=[];
night=[night;day218];
clear day218

k=find(data(:,1)<220);
day219=data(k,:);
data(k,:)=[];
k=find(day219(:,1)<219.2056);
```

```
night=[night;day219(k,:)];
day219(k,:)=[];
k=find(day219(:,1)<219.2472);
dawn=[dawn;day219(k,:)];
day219(k,:)=[];
k=find(day219(:,1)<219.7618);
day=[day;day219(k,:)];
day219(k,:)=[];
k=find(day219(:,1)<219.8035);
dusk=[dusk;day219(k,:)];
day219(k,:)=[];
night=[night;day219];
clear day219

k=find(data(:,1)<221);
day220=data(k,:);
data(k,:)=[];
k=find(day220(:,1)<220.2062);
night=[night;day220(k,:)];
day220(k,:)=[];
k=find(day220(:,1)<220.2479);
dawn=[dawn;day220(k,:)];
day220(k,:)=[];
k=find(day220(:,1)<220.7611);
day=[day;day220(k,:)];
day220(k,:)=[];
k=find(day220(:,1)<220.8028);
dusk=[dusk;day220(k,:)];
day220(k,:)=[];
night=[night;day220];
clear day220

k=find(data(:,1)<222);
day221=data(k,:);
data(k,:)=[];
k=find(day221(:,1)<221.2062);
night=[night;day221(k,:)];
day221(k,:)=[];
k=find(day221(:,1)<221.2479);
dawn=[dawn;day221(k,:)];
day221(k,:)=[];
k=find(day221(:,1)<221.7604);
day=[day;day221(k,:)];
day221(k,:)=[];
k=find(day221(:,1)<221.8021);
dusk=[dusk;day221(k,:)];
day221(k,:)=[];
night=[night;day221];
clear day221
```

```
k=find(data(:,1)<223);
day222=data(k,:);
data(k,:)=[];
k=find(day222(:,1)<222.2069);
night=[night;day222(k,:)];
day222(k,:)=[];
k=find(day222(:,1)<222.2486);
dawn=[dawn;day222(k,:)];
day222(k,:)=[];
k=find(day222(:,1)<222.7604);
day=[day;day222(k,:)];
day222(k,:)=[];
k=find(day222(:,1)<222.8021);
dusk=[dusk;day222(k,:)];
day222(k,:)=[];
night=[night;day222];
clear day222

k=find(data(:,1)<224);
day223=data(k,:);
data(k,:)=[];
k=find(day223(:,1)<223.2069);
night=[night;day223(k,:)];
day223(k,:)=[];
k=find(day223(:,1)<223.2486);
dawn=[dawn;day223(k,:)];
day223(k,:)=[];
k=find(day223(:,1)<223.7597);
day=[day;day223(k,:)];
day223(k,:)=[];
k=find(day223(:,1)<223.8014);
dusk=[dusk;day223(k,:)];
day223(k,:)=[];
night=[night;day223];
clear day223

k=find(data(:,1)<225);
day224=data(k,:);
data(k,:)=[];
k=find(day224(:,1)<224.2076);
night=[night;day224(k,:)];
day224(k,:)=[];
k=find(day224(:,1)<224.2493);
dawn=[dawn;day224(k,:)];
day224(k,:)=[];
k=find(day224(:,1)<224.7590);
day=[day;day224(k,:)];
day224(k,:)=[];
k=find(day224(:,1)<224.8007);
dusk=[dusk;day224(k,:)];
```

```
day224(k,:)=[];
night=[night;day224];
clear day224

k=find(data(:,1)<226);
day225=data(k,:);
data(k,:)=[];
k=find(day225(:,1)<225.2076);
night=[night;day225(k,:)];
day225(k,:)=[];
k=find(day225(:,1)<225.2493);
dawn=[dawn;day225(k,:)];
day225(k,:)=[];
k=find(day225(:,1)<225.7583);
day=[day;day225(k,:)];
day225(k,:)=[];
k=find(day225(:,1)<225.8000);
dusk=[dusk;day225(k,:)];
day225(k,:)=[];
night=[night;day225];
clear day225

k=find(data(:,1)<227);
day226=data(k,:);
data(k,:)=[];
k=find(day226(:,1)<226.2083);
night=[night;day226(k,:)];
day226(k,:)=[];
k=find(day226(:,1)<226.2500);
dawn=[dawn;day226(k,:)];
day226(k,:)=[];
k=find(day226(:,1)<226.7576);
day=[day;day226(k,:)];
day226(k,:)=[];
k=find(day226(:,1)<226.7993);
dusk=[dusk;day226(k,:)];
day226(k,:)=[];
night=[night;day226];
clear day226

k=find(data(:,1)<228);
day227=data(k,:);
data(k,:)=[];
k=find(day227(:,1)<227.2083);
night=[night;day227(k,:)];
day227(k,:)=[];
k=find(day227(:,1)<227.2500);
dawn=[dawn;day227(k,:)];
day227(k,:)=[];
k=find(day227(:,1)<227.7569);
```

```
day=[day;day227(k,:)];
day227(k,:)=[];
k=find(day227(:,1)<227.7986);
dusk=[dusk;day227(k,:)];
day227(k,:)=[];
night=[night;day227];
clear day227

k=find(data(:,1)<229);
day228=data(k,:);
data(k,:)=[];
k=find(day228(:,1)<228.2090);
night=[night;day228(k,:)];
day228(k,:)=[];
k=find(day228(:,1)<228.2507);
dawn=[dawn;day228(k,:)];
day228(k,:)=[];
k=find(day228(:,1)<228.7562);
day=[day;day228(k,:)];
day228(k,:)=[];
k=find(day228(:,1)<228.7979);
dusk=[dusk;day228(k,:)];
day228(k,:)=[];
night=[night;day228];
clear day228

k=find(data(:,1)<230);
day229=data(k,:);
data(k,:)=[];
k=find(day229(:,1)<229.2090);
night=[night;day229(k,:)];
day229(k,:)=[];
k=find(day229(:,1)<229.2507);
dawn=[dawn;day229(k,:)];
day229(k,:)=[];
k=find(day229(:,1)<229.7556);
day=[day;day229(k,:)];
day229(k,:)=[];
k=find(day229(:,1)<229.7972);
dusk=[dusk;day229(k,:)];
day229(k,:)=[];
night=[night;day229];
clear day229

k=find(data(:,1)<231);
day230=data(k,:);
data(k,:)=[];
k=find(day230(:,1)<230.2097);
night=[night;day230(k,:)];
day230(k,:)=[];
```

```
k=find(day230(:,1)<230.2514);
dawn=[dawn;day230(k,:)];
day230(k,:)=[];
k=find(day230(:,1)<230.7549);
day=[day;day230(k,:)];
day230(k,:)=[];
k=find(day230(:,1)<230.7965);
dusk=[dusk;day230(k,:)];
day230(k,:)=[];
night=[night;day230];
clear day230

k=find(data(:,1)<232);
day231=data(k,:);
data(k,:)=[];
k=find(day231(:,1)<231.2104);
night=[night;day231(k,:)];
day231(k,:)=[];
k=find(day231(:,1)<231.2521);
dawn=[dawn;day231(k,:)];
day231(k,:)=[];
k=find(day231(:,1)<231.7542);
day=[day;day231(k,:)];
day231(k,:)=[];
k=find(day231(:,1)<231.7958);
dusk=[dusk;day231(k,:)];
day231(k,:)=[];
night=[night;day231];
clear day231

k=find(data(:,1)<233);
day232=data(k,:);
data(k,:)=[];
k=find(day232(:,1)<232.2104);
night=[night;day232(k,:)];
day232(k,:)=[];
k=find(day232(:,1)<232.2521);
dawn=[dawn;day232(k,:)];
day232(k,:)=[];
k=find(day232(:,1)<232.7535);
day=[day;day232(k,:)];
day232(k,:)=[];
k=find(day232(:,1)<232.7951);
dusk=[dusk;day232(k,:)];
day232(k,:)=[];
night=[night;day232];
clear day232

k=find(data(:,1)<234);
day233=data(k,:);
```

```
data(k,:)=[];
k=find(day233(:,1)<233.2111);
night=[night;day233(k,:)];
day233(k,:)=[];
k=find(day233(:,1)<233.2528);
dawn=[dawn;day233(k,:)];
day233(k,:)=[];
k=find(day233(:,1)<233.7528);
day=[day;day233(k,:)];
day233(k,:)=[];
k=find(day233(:,1)<233.7944);
dusk=[dusk;day233(k,:)];
day233(k,:)=[];
night=[night;day233];
clear day233

k=find(data(:,1)<235);
day234=data(k,:);
data(k,:)=[];
k=find(day234(:,1)<234.2111);
night=[night;day234(k,:)];
day234(k,:)=[];
k=find(day234(:,1)<234.2528);
dawn=[dawn;day234(k,:)];
day234(k,:)=[];
k=find(day234(:,1)<234.7521);
day=[day;day234(k,:)];
day234(k,:)=[];
k=find(day234(:,1)<234.7938);
dusk=[dusk;day234(k,:)];
day234(k,:)=[];
night=[night;day234];
clear day234

k=find(data(:,1)<236);
day235=data(k,:);
data(k,:)=[];
k=find(day235(:,1)<235.2118);
night=[night;day235(k,:)];
day235(k,:)=[];
k=find(day235(:,1)<235.2535);
dawn=[dawn;day235(k,:)];
day235(k,:)=[];
k=find(day235(:,1)<235.7514);
day=[day;day235(k,:)];
day235(k,:)=[];
k=find(day235(:,1)<235.7931);
dusk=[dusk;day235(k,:)];
day235(k,:)=[];
night=[night;day235];
```

```
clear day235

k=find(data(:,1)<237);
day236=data(k,:);
data(k,:)=[];
k=find(day236(:,1)<236.2118);
night=[night;day236(k,:)];
day236(k,:)=[];
k=find(day236(:,1)<236.2535);
dawn=[dawn;day236(k,:)];
day236(k,:)=[];
k=find(day236(:,1)<236.7507);
day=[day;day236(k,:)];
day236(k,:)=[];
k=find(day236(:,1)<236.7924);
dusk=[dusk;day236(k,:)];
day236(k,:)=[];
night=[night;day236];
clear day236

k=find(data(:,1)<238);
day237=data(k,:);
data(k,:)=[];
k=find(day237(:,1)<237.2125);
night=[night;day237(k,:)];
day237(k,:)=[];
k=find(day237(:,1)<237.2542);
dawn=[dawn;day237(k,:)];
day237(k,:)=[];
k=find(day237(:,1)<237.7500);
day=[day;day237(k,:)];
day237(k,:)=[];
k=find(day237(:,1)<237.7917);
dusk=[dusk;day237(k,:)];
day237(k,:)=[];
night=[night;day237];
clear day237

k=find(data(:,1)<239);
day238=data(k,:);
data(k,:)=[];
k=find(day238(:,1)<238.2125);
night=[night;day238(k,:)];
day238(k,:)=[];
k=find(day238(:,1)<238.2542);
dawn=[dawn;day238(k,:)];
day238(k,:)=[];
k=find(day238(:,1)<238.7493);
day=[day;day238(k,:)];
day238(k,:)=[];
```

```
k=find(day238(:,1)<238.7910);
dusk=[dusk;day238(k,:)];
day238(k,:)=[];
night=[night;day238];
clear day238 k data
```

timeperiods06.m

```
%This routine separates the depth dist into 4 discrete time periods -
%night(all dist up to one half hour before sunrise and all dist after one
%hour after sunset), dawn (the period between one half hour before sunrise
%and one half hour after sunrise), day (the period between one half hour
%after sunrise and one half hour before sunset), dusk (the period between
%one half before sunset and one half hour after sunset).  This routine is only
%valid for the days between 15Aug06 and 11Oct06 in the Gulf of Mexico.

data=dist;

k=find(data(:,1)<228);%find all data for day 227
day227=(data(k,:));%assign data to new variable
data(k,:)=[];%delete data for day 217
k=find(day227(:,1)<227.2000333);%find data 1/2 before sunrise
night=day227(k,:);%assign data to new night variable
day227(k,:)=[];%delete night data
k=find(day227(:,1)<227.41633);%find data for dawn period
dawn=day227(k,:);%assign data to new dawn variable
day227(k,:)=[];%delete dawn data
k=find(day227(:,1)<227.7458667);%find daytime data
day=day227(k,:);%assign data to new day variable
day227(k,:)=[];%delete daytime data
k=find(day227(:,1)<227.7874667);%find data for dusk period
dusk=day227(k,:);%assign data to new dusk variable
day227(k,:)=[];%delete dusk data
night=[night;day227];%concat remaining data onto night variable
clear day227

k=find(data(:,1)<229);
day228=data(k,:);
data(k,:)=[];
k=find(day228(:,1)<228.20045);
night=[night;day228(k,:)];
day228(k,:)=[];
k=find(day228(:,1)<228.24205);
dawn=[dawn;day228(k,:)];
day228(k,:)=[];
k=find(day228(:,1)<228.74545);
day=[day;day228(k,:)];
day228(k,:)=[];
k=find(day228(:,1)<278705);
dusk=[dusk;day228(k,:)];
day228(k,:)=[];
night=[night;day228];
clear day228

k=find(data(:,1)<230);
day229=data(k,:);
```

```
data(k,:)=[];
k=find(day229(:,1)<229.20045);
night=[night;day229(k,:)];
day229(k,:)=[];
k=find(day229(:,1)<229.24205);
dawn=[dawn;day229(k,:)];
day229(k,:)=[];
k=find(day229(:,1)<229.7450333);
day=[day;day229(k,:)];
day229(k,:)=[];
k=find(day229(:,1)<229.7866333);
dusk=[dusk;day229(k,:)];
day229(k,:)=[];
night=[night;day229];
clear day229

k=find(data(:,1)<231);
day230=data(k,:);
data(k,:)=[];
k=find(day230(:,1)<230.2008667);
night=[night;day230(k,:)];
day230(k,:)=[];
k=find(day230(:,1)<230.2424667);
dawn=[dawn;day230(k,:)];
day230(k,:)=[];
k=find(day230(:,1)<230.7446167);
day=[day;day230(k,:)];
day230(k,:)=[];
k=find(day230(:,1)<230.7862167);
dusk=[dusk;day230(k,:)];
day230(k,:)=[];
night=[night;day230];
clear day230

k=find(data(:,1)<232);
day231=data(k,:);
data(k,:)=[];
k=find(day231(:,1)<231.2008667);
night=[night;day231(k,:)];
day231(k,:)=[];
k=find(day231(:,1)<231.2424667);
dawn=[dawn;day231(k,:)];
day231(k,:)=[];
k=find(day231(:,1)<231.7442);
day=[day;day231(k,:)];
day231(k,:)=[];
k=find(day231(:,1)<231.7858);
dusk=[dusk;day231(k,:)];
day231(k,:)=[];
night=[night;day231];
```

```
clear day231

k=find(data(:,1)<233);
day232=data(k,:);
data(k,:)=[];
k=find(day232(:,1)<232.2012833);
night=[night;day232(k,:)];
day232(k,:)=[];
k=find(day232(:,1)<232.2428833);
dawn=[dawn;day232(k,:)];
day232(k,:)=[];
k=find(day232(:,1)<232.7437833);
day=[day;day232(k,:)];
day232(k,:)=[];
k=find(day232(:,1)<232.7853833);
dusk=[dusk;day232(k,:)];
day232(k,:)=[];
night=[night;day232];
clear day232

k=find(data(:,1)<234);
day233=data(k,:);
data(k,:)=[];
k=find(day233(:,1)<233.2012833);
night=[night;day233(k,:)];
day233(k,:)=[];
k=find(day233(:,1)<233.2428833);
dawn=[dawn;day233(k,:)];
day233(k,:)=[];
k=find(day233(:,1)<233.74336677);
day=[day;day233(k,:)];
day233(k,:)=[];
k=find(day233(:,1)<233.7853833);
dusk=[dusk;day233(k,:)];
day233(k,:)=[];
night=[night;day233];
clear day233

k=find(data(:,1)<235);
day234=data(k,:);
data(k,:)=[];
k=find(day234(:,1)<234.2017);
night=[night;day234(k,:)];
day234(k,:)=[];
k=find(day234(:,1)<234.2433);
dawn=[dawn;day234(k,:)];
day234(k,:)=[];
k=find(day234(:,1)<234.74295);
day=[day;day234(k,:)];
day234(k,:)=[];
```

```
k=find(day234(:,1)<234.78455);
dusk=[dusk;day234(k,:)];
day234(k,:)=[];
night=[night;day234];
clear day234

k=find(data(:,1)<236);
day235=data(k,:);
data(k,:)=[];
k=find(day235(:,1)<235.2021167);
night=[night;day235(k,:)];
day235(k,:)=[];
k=find(day235(:,1)<235.2437167);
dawn=[dawn;day235(k,:)];
day235(k,:)=[];
k=find(day235(:,1)<235.7425333);
day=[day;day235(k,:)];
day235(k,:)=[];
k=find(day235(:,1)<235.7841333);
dusk=[dusk;day235(k,:)];
day235(k,:)=[];
night=[night;day235];
clear day235

k=find(data(:,1)<237);
day236=data(k,:);
data(k,:)=[];
k=find(day236(:,1)<236.2021167);
night=[night;day236(k,:)];
day236(k,:)=[];
k=find(day236(:,1)<236.2437167);
dawn=[dawn;day236(k,:)];
day236(k,:)=[];
k=find(day236(:,1)<236.7421167);
day=[day;day236(k,:)];
day236(k,:)=[];
k=find(day236(:,1)<236.7837167);
dusk=[dusk;day236(k,:)];
day236(k,:)=[];
night=[night;day236];
clear day236

k=find(data(:,1)<238);
day237=data(k,:);
data(k,:)=[];
k=find(day237(:,1)<237.2025333);
night=[night;day237(k,:)];
day237(k,:)=[];
k=find(day237(:,1)<237.2441333);
dawn=[dawn;day237(k,:)];
```

```
day237(k,:)=[];
k=find(day237(:,1)<237.7417);
day=[day;day237(k,:)];
day237(k,:)=[];
k=find(day237(:,1)<237.7833);
dusk=[dusk;day237(k,:)];
day237(k,:)=[];
night=[night;day237];
clear day237

k=find(data(:,1)<239);
day238=data(k,:);
data(k,:)=[];
k=find(day238(:,1)<238.2025333);
night=[night;day238(k,:)];
day238(k,:)=[];
k=find(day238(:,1)<238.2441333);
dawn=[dawn;day238(k,:)];
day238(k,:)=[];
k=find(day238(:,1)<238.7412833);
day=[day;day238(k,:)];
day238(k,:)=[];
k=find(day238(:,1)<238.7828833);
dusk=[dusk;day238(k,:)];
day238(k,:)=[];
night=[night;day238];
clear day238

k=find(data(:,1)<240);
day239=data(k,:);
data(k,:)=[];
k=find(day239(:,1)<239.20295);
night=[night;day239(k,:)];
day239(k,:)=[];
k=find(day239(:,1)<239.24455);
dawn=[dawn;day239(k,:)];
day239(k,:)=[];
k=find(day239(:,1)<239.7408667);
day=[day;day239(k,:)];
day239(k,:)=[];
k=find(day239(:,1)<239.7824667);
dusk=[dusk;day239(k,:)];
day239(k,:)=[];
night=[night;day239];
clear day239

k=find(data(:,1)<241);
day240=data(k,:);
data(k,:)=[];
k=find(day240(:,1)<240.20295);
```

```
night=[night;day240(k,:)];
day240(k,:)=[];
k=find(day240(:,1)<240.24455);
dawn=[dawn;day240(k,:)];
day240(k,:)=[];
k=find(day240(:,1)<240.74045);
day=[day;day240(k,:)];
day240(k,:)=[];
k=find(day240(:,1)<240.78205);
dusk=[dusk;day240(k,:)];
day240(k,:)=[];
night=[night;day240];
clear day240

k=find(data(:,1)<242);
day241=data(k,:);
data(k,:)=[];
k=find(day241(:,1)<241.2033667);
night=[night;day241(k,:)];
day241(k,:)=[];
k=find(day241(:,1)<241.244967);
dawn=[dawn;day241(k,:)];
day241(k,:)=[];
k=find(day241(:,1)<241.7400333);
day=[day;day241(k,:)];
day241(k,:)=[];
k=find(day241(:,1)<241.7816333);
dusk=[dusk;day241(k,:)];
day241(k,:)=[];
night=[night;day241];
clear day241

k=find(data(:,1)<243);
day242=data(k,:);
data(k,:)=[];
k=find(day242(:,1)<242.2033667);
night=[night;day242(k,:)];
day242(k,:)=[];
k=find(day242(:,1)<242.2449667);
dawn=[dawn;day242(k,:)];
day242(k,:)=[];
k=find(day242(:,1)<242.7396167);
day=[day;day242(k,:)];
day242(k,:)=[];
k=find(day242(:,1)<242.7812167);
dusk=[dusk;day242(k,:)];
day242(k,:)=[];
night=[night;day242];
clear day242
```

```
k=find(data(:,1)<244);
day243=data(k,:);
data(k,:)=[];
k=find(day243(:,1)<243.2037833);
night=[night;day243(k,:)];
day243(k,:)=[];
k=find(day243(:,1)<243.2453833);
dawn=[dawn;day243(k,:)];
day243(k,:)=[];
k=find(day243(:,1)<243.739);
day=[day;day243(k,:)];
day243(k,:)=[];
k=find(day243(:,1)<243.7808);
dusk=[dusk;day243(k,:)];
day243(k,:)=[];
night=[night;day243];
clear day243

k=find(data(:,1)<245);
day244=data(k,:);
data(k,:)=[];
k=find(day244(:,1)<244.2037833);
night=[night;day244(k,:)];
day244(k,:)=[];
k=find(day244(:,1)<244.2037833);
dawn=[dawn;day244(k,:)];
day244(k,:)=[];
k=find(day244(:,1)<244.7383667);
day=[day;day244(k,:)];
day244(k,:)=[];
k=find(day244(:,1)<244.7799667);
dusk=[dusk;day244(k,:)];
day244(k,:)=[];
night=[night;day244];
clear day244

k=find(data(:,1)<246);
day245=data(k,:);
data(k,:)=[];
k=find(day245(:,1)<245.2042);
night=[night;day245(k,:)];
day245(k,:)=[];
k=find(day245(:,1)<245.2458);
dawn=[dawn;day245(k,:)];
day245(k,:)=[];
k=find(day245(:,1)<245.73795);
day=[day;day245(k,:)];
day245(k,:)=[];
k=find(day245(:,1)<245.77955);
dusk=[dusk;day245(k,:)];
```

```
day245(k,:)=[];
night=[night;day245];
clear day245

k=find(data(:,1)<247);
day246=data(k,:);
data(k,:)=[];
k=find(day246(:,1)<246.2042);
night=[night;day246(k,:)];
day246(k,:)=[];
k=find(day246(:,1)<246.2458);
dawn=[dawn;day246(k,:)];
day246(k,:)=[];
k=find(day246(:,1)<246.7375333);
day=[day;day246(k,:)];
day246(k,:)=[];
k=find(day246(:,1)<246.7791333);
dusk=[dusk;day246(k,:)];
day246(k,:)=[];
night=[night;day246];
clear day246

k=find(data(:,1)<248);
day247=data(k,:);
data(k,:)=[];
k=find(day247(:,1)<247.2046167);
night=[night;day247(k,:)];
day247(k,:)=[];
k=find(day247(:,1)<247.2462167);
dawn=[dawn;day247(k,:)];
day247(k,:)=[];
k=find(day247(:,1)<247.7371167);
day=[day;day247(k,:)];
day247(k,:)=[];
k=find(day247(:,1)<247.7787167);
dusk=[dusk;day247(k,:)];
day247(k,:)=[];
night=[night;day247];
clear day247

k=find(data(:,1)<249);
day248=data(k,:);
data(k,:)=[];
k=find(day248(:,1)<248.2046167);
night=[night;day248(k,:)];
day248(k,:)=[];
k=find(day248(:,1)<248.2462167);
dawn=[dawn;day248(k,:)];
day248(k,:)=[];
k=find(day248(:,1)<248.7367);
```

```
day=[day;day248(k,:)];
day248(k,:)=[];
k=find(day248(:,1)<248.7783);
dusk=[dusk;day248(k,:)];
day248(k,:)=[];
night=[night;day248];
clear day248

k=find(data(:,1)<250);
day249=data(k,:);
data(k,:)=[];
k=find(day249(:,1)<249.2050333);
night=[night;day249(k,:)];
day249(k,:)=[];
k=find(day249(:,1)<249.2466333);
dawn=[dawn;day249(k,:)];
day249(k,:)=[];
k=find(day249(:,1)<249.7362833);
day=[day;day249(k,:)];
day249(k,:)=[];
k=find(day249(:,1)<249.7778833);
dusk=[dusk;day249(k,:)];
day249(k,:)=[];
night=[night;day249];
clear day249

k=find(data(:,1)<251);
day250=data(k,:);
data(k,:)=[];
k=find(day250(:,1)<250.2050333);
night=[night;day250(k,:)];
day250(k,:)=[];
k=find(day250(:,1)<250.2466333);
dawn=[dawn;day250(k,:)];
day250(k,:)=[];
k=find(day250(:,1)<250.73545);
day=[day;day250(k,:)];
day250(k,:)=[];
k=find(day250(:,1)<250.77705);
dusk=[dusk;day250(k,:)];
day250(k,:)=[];
night=[night;day250];
clear day250

k=find(data(:,1)<252);
day251=data(k,:);
data(k,:)=[];
k=find(day251(:,1)<251.20545);
night=[night;day251(k,:)];
day251(k,:)=[];
```

```
k=find(day251(:,1)<251.24705);
dawn=[dawn;day251(k,:)];
day251(k,:)=[];
k=find(day251(:,1)<251.7350333);
day=[day;day251(k,:)];
day251(k,:)=[];
k=find(day251(:,1)<261.7766333);
dusk=[dusk;day251(k,:)];
day251(k,:)=[];
night=[night;day251];
clear day251

k=find(data(:,1)<253);
day252=data(k,:);
data(k,:)=[];
k=find(day252(:,1)<252.20545);
night=[night;day252(k,:)];
day252(k,:)=[];
k=find(day252(:,1)<252.24705);
dawn=[dawn;day252(k,:)];
day252(k,:)=[];
k=find(day252(:,1)<252.7346167);
day=[day;day252(k,:)];
day252(k,:)=[];
k=find(day252(:,1)<252.7762167);
dusk=[dusk;day252(k,:)];
day252(k,:)=[];
night=[night;day252];
clear day252

k=find(data(:,1)<254);
day253=data(k,:);
data(k,:)=[];
k=find(day253(:,1)<253.2058667);
night=[night;day253(k,:)];
day253(k,:)=[];
k=find(day253(:,1)<253.2474667);
dawn=[dawn;day253(k,:)];
day253(k,:)=[];
k=find(day253(:,1)<253.7342);
day=[day;day253(k,:)];
day253(k,:)=[];
k=find(day253(:,1)<253.7758);
dusk=[dusk;day253(k,:)];
day253(k,:)=[];
night=[night;day253];
clear day253

k=find(data(:,1)<255);
day254=data(k,:);
```

```
data(k,:)=[];
k=find(day254(:,1)<254.2058667);
night=[night;day254(k,:)];
day254(k,:)=[];
k=find(day254(:,1)<254.2474667);
dawn=[dawn;day254(k,:)];
day254(k,:)=[];
k=find(day254(:,1)<254.7337833);
day=[day;day254(k,:)];
day254(k,:)=[];
k=find(day254(:,1)<254.7753833);
dusk=[dusk;day254(k,:)];
day254(k,:)=[];
night=[night;day254];
clear day254

k=find(data(:,1)<256);
day255=data(k,:);
data(k,:)=[];
k=find(day255(:,1)<255.2062833);
night=[night;day255(k,:)];
day255(k,:)=[];
k=find(day255(:,1)<255.2478833);
dawn=[dawn;day255(k,:)];
day255(k,:)=[];
k=find(day255(:,1)<255.7333667);
day=[day;day255(k,:)];
day255(k,:)=[];
k=find(day255(:,1)<255.7749667);
dusk=[dusk;day255(k,:)];
day255(k,:)=[];
night=[night;day255];
clear day255

k=find(data(:,1)<257);
day256=data(k,:);
data(k,:)=[];
k=find(day256(:,1)<256.2062833);
night=[night;day256(k,:)];
day256(k,:)=[];
k=find(day256(:,1)<256.2478833);
dawn=[dawn;day256(k,:)];
day256(k,:)=[];
k=find(day256(:,1)<256.7325333);
day=[day;day256(k,:)];
day256(k,:)=[];
k=find(day256(:,1)<256.7741333);
dusk=[dusk;day256(k,:)];
day256(k,:)=[];
night=[night;day256];
```

```
clear day256

k=find(data(:,1)<258);
day257=data(k,:);
data(k,:)=[];
k=find(day257(:,1)<257.2062833);
night=[night;day257(k,:)];
day257(k,:)=[];
k=find(day257(:,1)<257.2478833);
dawn=[dawn;day257(k,:)];
day257(k,:)=[];
k=find(day257(:,1)<257.7321167);
day=[day;day257(k,:)];
day257(k,:)=[];
k=find(day257(:,1)<257.7737167);
dusk=[dusk;day257(k,:)];
day257(k,:)=[];
night=[night;day257];
clear day257

k=find(data(:,1)<259);
day258=data(k,:);
data(k,:)=[];
k=find(day258(:,1)<258.2067);
night=[night;day258(k,:)];
day258(k,:)=[];
k=find(day258(:,1)<258.2483);
dawn=[dawn;day258(k,:)];
day258(k,:)=[];
k=find(day258(:,1)<258.7317);
day=[day;day258(k,:)];
day258(k,:)=[];
k=find(day258(:,1)<258.7733);
dusk=[dusk;day258(k,:)];
day258(k,:)=[];
night=[night;day258];
clear day258

k=find(data(:,1)<260);
day259=data(k,:);
data(k,:)=[];
k=find(day259(:,1)<259.2067);
night=[night;day259(k,:)];
day259(k,:)=[];
k=find(day259(:,1)<259.2483);
dawn=[dawn;day259(k,:)];
day259(k,:)=[];
k=find(day259(:,1)<259.7312833);
day=[day;day259(k,:)];
day259(k,:)=[];
```

```
k=find(day259(:,1)<259.7728833);
dusk=[dusk;day259(k,:)];
day259(k,:)=[];
night=[night;day259];
clear day259

k=find(data(:,1)<261);
day260=data(k,:);
data(k,:)=[];
k=find(day260(:,1)<260.2071167);
night=[night;day260(k,:)];
day260(k,:)=[];
k=find(day260(:,1)<260.2487167);
dawn=[dawn;day260(k,:)];
day260(k,:)=[];
k=find(day260(:,1)<260.7308667);
day=[day;day260(k,:)];
day260(k,:)=[];
k=find(day260(:,1)<260.7724667);
dusk=[dusk;day260(k,:)];
day260(k,:)=[];
night=[night;day260];
clear day260

k=find(data(:,1)<262);
day261=data(k,:);
data(k,:)=[];
k=find(day261(:,1)<261.2071167);
night=[night;day261(k,:)];
day261(k,:)=[];
k=find(day261(:,1)<261.2487167);
dawn=[dawn;day261(k,:)];
day261(k,:)=[];
k=find(day261(:,1)<261.7300333);
day=[day;day261(k,:)];
day261(k,:)=[];
k=find(day261(:,1)<261.7716333);
dusk=[dusk;day261(k,:)];
day261(k,:)=[];
night=[night;day261];
clear day261

k=find(data(:,1)<263);
day262=data(k,:);
data(k,:)=[];
k=find(day262(:,1)<262.2075333);
night=[night;day262(k,:)];
day262(k,:)=[];
k=find(day262(:,1)<262.2491333);
dawn=[dawn;day262(k,:)];
```

```
day262(k,:)=[];
k=find(day262(:,1)<262.7296167);
day=[day;day262(k,:)];
day262(k,:)=[];
k=find(day262(:,1)<262.7712167);
dusk=[dusk;day262(k,:)];
day262(k,:)=[];
night=[night;day262];
clear day262

k=find(data(:,1)<264);
day263=data(k,:);
data(k,:)=[];
k=find(day263(:,1)<263.2075333);
night=[night;day263(k,:)];
day263(k,:)=[];
k=find(day263(:,1)<263.2491333);
dawn=[dawn;day263(k,:)];
day263(k,:)=[];
k=find(day263(:,1)<263.7292);
day=[day;day263(k,:)];
day263(k,:)=[];
k=find(day263(:,1)<263.7708);
dusk=[dusk;day263(k,:)];
day263(k,:)=[];
night=[night;day263];
clear day263

k=find(data(:,1)<265);
day264=data(k,:);
data(k,:)=[];
k=find(day264(:,1)<264.20795);
night=[night;day264(k,:)];
day264(k,:)=[];
k=find(day264(:,1)<264.24955);
dawn=[dawn;day264(k,:)];
day264(k,:)=[];
k=find(day264(:,1)<264.7121167);
day=[day;day264(k,:)];
day264(k,:)=[];
k=find(day264(:,1)<264.7537167);
dusk=[dusk;day264(k,:)];
day264(k,:)=[];
night=[night;day264];
clear day264

k=find(data(:,1)<266);
day265=data(k,:);
data(k,:)=[];
k=find(day265(:,1)<265.20795);
```

```
night=[night;day265(k,:)];
day265(k,:)=[];
k=find(day265(:,1)<265.24955);
dawn=[dawn;day265(k,:)];
day265(k,:)=[];
k=find(day265(:,1)<265.7117);
day=[day;day265(k,:)];
day265(k,:)=[];
k=find(day265(:,1)<265.7533);
dusk=[dusk;day265(k,:)];
day265(k,:)=[];
night=[night;day265];
clear day265

k=find(data(:,1)<267);
day266=data(k,:);
data(k,:)=[];
k=find(day266(:,1)<266.2083667);
night=[night;day266(k,:)];
day266(k,:)=[];
k=find(day266(:,1)<266.2499667);
dawn=[dawn;day266(k,:)];
day266(k,:)=[];
k=find(day266(:,1)<266.7108667);
day=[day;day266(k,:)];
day266(k,:)=[];
k=find(day266(:,1)<266.7524667);
dusk=[dusk;day266(k,:)];
day266(k,:)=[];
night=[night;day266];
clear day266

k=find(data(:,1)<268);
day267=data(k,:);
data(k,:)=[];
k=find(day267(:,1)<267.2083667);
night=[night;day267(k,:)];
day267(k,:)=[];
k=find(day267(:,1)<267.2499667);
dawn=[dawn;day267(k,:)];
day267(k,:)=[];
k=find(day267(:,1)<267.71045);
day=[day;day267(k,:)];
day267(k,:)=[];
k=find(day267(:,1)<267.75205);
dusk=[dusk;day267(k,:)];
day267(k,:)=[];
night=[night;day267];
clear day267
```

```
k=find(data(:,1)<269);
day268=data(k,:);
data(k,:)=[];
k=find(day268(:,1)<268.2087833);
night=[night;day268(k,:)];
day268(k,:)=[];
k=find(day268(:,1)<268.2503833);
dawn=[dawn;day268(k,:)];
day268(k,:)=[];
k=find(day268(:,1)<268.7100333);
day=[day;day268(k,:)];
day268(k,:)=[];
k=find(day268(:,1)<268.7516333);
dusk=[dusk;day268(k,:)];
day268(k,:)=[];
night=[night;day268];
clear day268

k=find(data(:,1)<270);
day269=data(k,:);
data(k,:)=[];
k=find(day269(:,1)<269.2087833);
night=[night;day269(k,:)];
day269(k,:)=[];
k=find(day269(:,1)<269.25303833);
dawn=[dawn;day269(k,:)];
day269(k,:)=[];
k=find(day269(:,1)<269.7096167);
day=[day;day269(k,:)];
day269(k,:)=[];
k=find(day269(:,1)<269.7512167);
dusk=[dusk;day269(k,:)];
day269(k,:)=[];
night=[night;day269];
clear day269

k=find(data(:,1)<271);
day270=data(k,:);
data(k,:)=[];
k=find(day270(:,1)<270.2092);
night=[night;day270(k,:)];
day270(k,:)=[];
k=find(day270(:,1)<270.2508);
dawn=[dawn;day270(k,:)];
day270(k,:)=[];
k=find(day270(:,1)<270.7092);
day=[day;day270(k,:)];
day270(k,:)=[];
k=find(day270(:,1)<270.7508);
dusk=[dusk;day270(k,:)];
```

```
day270(k,:)=[];
night=[night;day270];
clear day270

k=find(data(:,1)<272);
day271=data(k,:);
data(k,:)=[];
k=find(day271(:,1)<271.2092);
night=[night;day271(k,:)];
day271(k,:)=[];
k=find(day271(:,1)<271.2508);
dawn=[dawn;day271(k,:)];
day271(k,:)=[];
k=find(day271(:,1)<271.7083667);
day=[day;day271(k,:)];
day271(k,:)=[];
k=find(day271(:,1)<271.7499667);
dusk=[dusk;day271(k,:)];
day271(k,:)=[];
night=[night;day271];
clear day271

k=find(data(:,1)<273);
day272=data(k,:);
data(k,:)=[];
k=find(day272(:,1)<272.2096167);
night=[night;day272(k,:)];
day272(k,:)=[];
k=find(day272(:,1)<272.2512167);
dawn=[dawn;day272(k,:)];
day272(k,:)=[];
k=find(day272(:,1)<272.70795);
day=[day;day272(k,:)];
day272(k,:)=[];
k=find(day272(:,1)<272.74955);
dusk=[dusk;day272(k,:)];
day272(k,:)=[];
night=[night;day272];
clear day272

k=find(data(:,1)<274);
day273=data(k,:);
data(k,:)=[];
k=find(day273(:,1)<273.2096167);
night=[night;day273(k,:)];
day273(k,:)=[];
k=find(day273(:,1)<273.2512167);
dawn=[dawn;day273(k,:)];
day273(k,:)=[];
k=find(day273(:,1)<273.7075333);
```

```
day=[day;day273(k,:)];
day273(k,:)=[];
k=find(day273(:,1)<273.7491333);
dusk=[dusk;day273(k,:)];
day273(k,:)=[];
night=[night;day273];
clear day273

k=find(data(:,1)<275);
day274=data(k,:);
data(k,:)=[];
k=find(day274(:,1)<274.2100333);
night=[night;day274(k,:)];
day274(k,:)=[];
k=find(day274(:,1)<274.2516333);
dawn=[dawn;day274(k,:)];
day274(k,:)=[];
k=find(day274(:,1)<274.7071167);
day=[day;day274(k,:)];
day274(k,:)=[];
k=find(day274(:,1)<274.7487167);
dusk=[dusk;day274(k,:)];
day274(k,:)=[];
night=[night;day274];
clear day274

k=find(data(:,1)<276);
day275=data(k,:);
data(k,:)=[];
k=find(day275(:,1)<275.21045);
night=[night;day275(k,:)];
day275(k,:)=[];
k=find(day275(:,1)<275.25202);
dawn=[dawn;day275(k,:)];
day275(k,:)=[];
k=find(day275(:,1)<275.70545);
day=[day;day275(k,:)];
day275(k,:)=[];
k=find(day275(:,1)<275.7483);
dusk=[dusk;day275(k,:)];
day275(k,:)=[];
night=[night;day275];
clear day275

k=find(data(:,1)<277);
day276=data(k,:);
data(k,:)=[];
k=find(day276(:,1)<276.21045);
night=[night;day276(k,:)];
day276(k,:)=[];
```

```
k=find(day276(:,1)<276.25205);
dawn=[dawn;day276(k,:)];
day276(k,:)=[];
k=find(day276(:,1)<276.7062833);
day=[day;day276(k,:)];
day276(k,:)=[];
k=find(day276(:,1)<276.7478833);
dusk=[dusk;day276(k,:)];
day276(k,:)=[];
night=[night;day276];
clear day276

k=find(data(:,1)<278);
day277=data(k,:);
data(k,:)=[];
k=find(day277(:,1)<277.2108667);
night=[night;day277(k,:)];
day277(k,:)=[];
k=find(day277(:,1)<277.2524667);
dawn=[dawn;day277(k,:)];
day277(k,:)=[];
k=find(day277(:,1)<277.70545);
day=[day;day277(k,:)];
day277(k,:)=[];
k=find(day277(:,1)<277.74705);
dusk=[dusk;day277(k,:)];
day277(k,:)=[];
night=[night;day277];
clear day277

k=find(data(:,1)<279);
day278=data(k,:);
data(k,:)=[];
k=find(day278(:,1)<278.2108667);
night=[night;day278(k,:)];
day278(k,:)=[];
k=find(day278(:,1)<278.2524667);
dawn=[dawn;day278(k,:)];
day278(k,:)=[];
k=find(day278(:,1)<278.7050333);
day=[day;day278(k,:)];
day278(k,:)=[];
k=find(day278(:,1)<278.7466333);
dusk=[dusk;day278(k,:)];
day278(k,:)=[];
night=[night;day278];
clear day278

k=find(data(:,1)<280);
day279=data(k,:);
```

```
data(k,:)=[];
k=find(day279(:,1)<279.2112833);
night=[night;day279(k,:)];
day279(k,:)=[];
k=find(day279(:,1)<279.2528833);
dawn=[dawn;day279(k,:)];
day279(k,:)=[];
k=find(day279(:,1)<279.7046167);
day=[day;day279(k,:)];
day279(k,:)=[];
k=find(day279(:,1)<279.7462167);
dusk=[dusk;day279(k,:)];
day279(k,:)=[];
night=[night;day279];
clear day279

k=find(data(:,1)<281);
day280=data(k,:);
data(k,:)=[];
k=find(day280(:,1)<280.2112833);
night=[night;day280(k,:)];
day280(k,:)=[];
k=find(day280(:,1)<280.2528833);
dawn=[dawn;day280(k,:)];
day280(k,:)=[];
k=find(day280(:,1)<280.7042);
day=[day;day280(k,:)];
day280(k,:)=[];
k=find(day280(:,1)<280.7458);
dusk=[dusk;day280(k,:)];
day280(k,:)=[];
night=[night;day280];
clear day280

k=find(data(:,1)<282);
day281=data(k,:);
data(k,:)=[];
k=find(day281(:,1)<281.2117);
night=[night;day281(k,:)];
day281(k,:)=[];
k=find(day281(:,1)<281.2533);
dawn=[dawn;day281(k,:)];
day281(k,:)=[];
k=find(day281(:,1)<281.7037833);
day=[day;day281(k,:)];
day281(k,:)=[];
k=find(day281(:,1)<281.7453833);
dusk=[dusk;day281(k,:)];
day281(k,:)=[];
night=[night;day281];
```

```
clear day281

k=find(data(:,1)<283);
day282=data(k,:);
data(k,:)=[];
k=find(day282(:,1)<282.2117);
night=[night;day282(k,:)];
day282(k,:)=[];
k=find(day282(:,1)<282.2533);
dawn=[dawn;day282(k,:)];
day282(k,:)=[];
k=find(day282(:,1)<282.7033667);
day=[day;day282(k,:)];
day282(k,:)=[];
k=find(day282(:,1)<282.7449667);
dusk=[dusk;day282(k,:)];
day282(k,:)=[];
night=[night;day282];
clear day282

k=find(data(:,1)<284);
day283=data(k,:);
data(k,:)=[];
k=find(day283(:,1)<283.2121167);
night=[night;day283(k,:)];
day283(k,:)=[];
k=find(day283(:,1)<283.2537167);
dawn=[dawn;day283(k,:)];
day283(k,:)=[];
k=find(day283(:,1)<283.70295);
day=[day;day283(k,:)];
day283(k,:)=[];
k=find(day283(:,1)<283.74455);
dusk=[dusk;day283(k,:)];
day283(k,:)=[];
night=[night;day283];
clear day283

k=find(data(:,1)<285);
day284=data(k,:);
data(k,:)=[];
k=find(day284(:,1)<284.2121167);
night=[night;day284(k,:)];
day284(k,:)=[];
k=find(day284(:,1)<284.2537167);
dawn=[dawn;day284(k,:)];
day284(k,:)=[];
k=find(day284(:,1)<284.7025333);
day=[day;day284(k,:)];
day284(k,:)=[];
```

```
k=find(day284(:,1)<284.7441333);
dusk=[dusk;day284(k,:)];
day284(k,:)=[];
night=[night;day284];
clear k data day2*
```

tzinterp.m

```
for c=1:23

zfiles=['br29500_smoothed';'br30200_smoothed';'br30500_smoothed';'br30600_smooth
ed';...

'br30800_smoothed';'br31300_smoothed';'br31800_smoothed';'br32100_smoothed';...

'br32500_smoothed';'br32700_smoothed';'br32900_smoothed';'br33000_smoothed';...

'br33300_smoothed';'br33500_smoothed';'br33700_smoothed';'br33800_smoothed';...

'br34000_smoothed';'br34200_smoothed';'br34300_smoothed';'br34600_smoothed';...
   'br34800_smoothed';'br34900_smoothed';'br35000_smoothed'];
   eval(['load ' char(zfiles(c,:)) ';'])
   clear d* f* n* zf* a

   data=who;
   depths=[];

   for b=1:length(data)-c
      eval(['depths=[depths;' char(data(b)) '];'])
   end

   clear a* b data

tfiles=['br29500';'br30200';'br30500';'br30600';'br30800';'br31300';'br31800';'br32100';...
   'br32500';'br32700';'br32900';'br33000';'br33300';'br33500';'br33700';'br33800';...
   'br34000';'br34200';'br34300';'br34600';'br34800';'br34900';'br35000'];
   load dailytemp
   clear a* data

   eval(['temps=' char(tfiles(c,:)) ';']);
   clear b*
   temps(:,1)=[];

   temps=sortrows(temps,[1 2]);
   k=find((temps(2:end,1)-temps(1:end-1,1))==0);
   temps(k,:)=[];
   clear k

   time1s=(temps(1,1):1/(24*60*60):temps(end,1))';
   temps1s=interp1(temps(:,1),temps(:,2),time1s,'linear');
   temps1s=[time1s temps1s];
   clear time1s k

   k=find(depths(:,4)==0);
   depths(k,:)=[];
   k=find(depths(:,1)==0);
```

```
depths(k,:)=[];
min(depths(:,1));
k=find(depths(:,1)==ans);
depths(1:k-1,:)=[];
if isnan(depths(1,1))
    depths(1,:)=[];
end

if isnan(depths(end,1))
    depths(end,:)=[];
end
clear k ans

k=find(temps1s(:,1)>=depths(1,1) & temps1s(:,1)<=depths(end,1));
temps1s=temps1s(k,:);
clear k

tmp2=interp1(temps1s(:,1),temps1s(:,2),depths(:,1));
depths=[depths tmp2];

clear tmp2 temps1s

if isnan(depths(1,5))
depths(1,:)=[];
end

if isnan(depths(end,5))
    depths(end,:)=[];
end

k=find(depths(:,5)>35);
depths(k,:)=[];
clear k

k=find(depths(:,5)<23);
depths(k,:)=[];
clear k

a=isnan(depths(:,1));
b=find(a==1);
section1=depths(1:b(1)-1,:);
clear a

if numel(section1(:,1))>=5,
for a=3:length(section1(:,1))-2,
    smooth_br_5s(a,1)=section1(a,1);
    smooth_br_5s(a,2:5)=mean(section1(a-2:a+2,2:5));
end;
    smooth_br_5s(1:2,1)=section1(1:2,1);
    smooth_br_5s(1,2:5)=mean(section1(1:2,2:5));
```

```
    smooth_br_5s(2,2:5)=mean(section1(2:3,2:5));
    smooth_br_5s(end,2:5)=mean(section1(end-1:end,2:5));
elseif numel(section1(:,1))==4,
    smooth_br_5s(1,2:5)=mean(section1(1:2,2:5));
    smooth_br_5s(2,2:5)=mean(section1(1:3,2:5));
    smooth_br_5s(3,2:5)=mean(section1(2:5,2:5));
    smooth_br_5s(4,2:5)=mean(section1(3:4,2:5));
elseif numel(section1(:,1))==3,
    smooth_br_5s(1:3,1)=section1(1:3,1);
    smooth_br_5s(1,2:5)=mean(section1(1:2,2:5));
    smooth_br_5s(2,2:5)=mean(section1(1:3,2:5));
    smooth_br_5s(3,2:5)=mean(section1(2:3,2:5));
elseif numel(section1(:,1))<=2,
    smooth_br_5s=[section1;NaN NaN NaN NaN NaN];
end;
smooth_br_5s=[smooth_br_5s;NaN NaN NaN NaN NaN];
clear a section1

for a=1:length(b)-1,
    section2=depths(b(a)+1:b(a+1)-1,:);
    if numel(section2(:,1))>=5,
        for d=3:length(section2(:,1))-2,
            temp_smooth_5s(d,1)=section2(d,1);
            temp_smooth_5s(d,2:5)=mean(section2(d-2:d+2,2:5));
        end;
        temp_smooth_5s(1,:)=mean( section2(1:2,:));
        temp_smooth_5s(2,:)=mean(section2(2:3,:));
        temp_smooth_5s(end,2:5)=mean(section2(end-1:end,2:5));
    elseif numel(section2(:,1))==4,
        temp_smooth_5s(1,:)=mean(section2(1:2,:));
        temp_smooth_5s(2,:)=mean(section2(1:3,:));
        temp_smooth_5s(3,:)=mean(section2(2:4,:));
        temp_smooth_5s(4,:)=mean(section2(3:4,:));
    elseif numel(section2(:,1))==3,
        temp_smooth_5s(1,:)=mean(section2(1:2,:));
        temp_smooth_5s(2,:)=mean(section2(1:3,:));
        temp_smooth_5s(3,:)=mean(section2(2:3,:));
    elseif numel(section2(:,1))<=2,
        temp_smooth_5s=section2;
    end;
    smooth_br_5s=[smooth_br_5s;temp_smooth_5s;NaN NaN NaN NaN NaN];
    clear section2 temp_smooth_5s
end;

section1=depths(b(end)+1:end,:);
clear a;
if numel(section1(:,1))>=5,
    for a=3:length(section1(:,1))-2,
        temp_smooth_5s(1:2,1)=section1(1:2,1);
        temp_smooth_5s(a,1)=section1(a,1);
```

```
            temp_smooth_5s(a,2:5)=mean(section1(a-2:a+2,2:5));
        end;
        temp_smooth_5s(1,2:5)=section1(1,2:5);
        temp_smooth_5s(2,2:5)=mean(section1(1:2,2:5));
        temp_smooth_5s(end,2:5)=mean(section1(end-1:end,2:5));
    elseif numel(section1(:,1))==4,
        temp_smooth_5s(1,:)=mean(section1(1:2,:));
        temp_smooth_5s(2,:)=mean(section1(1:3,:));
        temp_smooth_5s(3,:)=mean(section1(2:4,:));
        temp_smooth_5s(4,:)=mean(section1(3:4,:));
    elseif numel(section1(:,1))==3,
        temp_smooth_5s(1,:)=mean(section1(1:2,:));
        temp_smooth_5s(2,:)=mean(section1(1:3,:));
        temp_smooth_5s(3,:)=mean(section1(2:3,:));
    elseif numel(section1(:,1))<=2,
        temp_smooth_5s=(section1);
    end;
    smooth_br_5s=[smooth_br_5s;temp_smooth_5s];
    eval(['zt_' char(tfiles(c,1:7)) '=smooth_br_5s;'])
    clear s* t* a b d*
end
clear c
```

vertmig.m

```
k=find(migrations(1,:)==fish);
migr=migrations(:,k:k+3);
migr(1,:)=[];

[rows cols]=size(migr);

ascending=[];
for a=1:rows
   k=find(data(:,2)>=migr(a,1)-.1 & data(:,2)<migr(a,1)+.1);
   temp=data(k,2:3);
   k=find(temp(:,2)>=(migr(a,2)-4) & temp(:,2)<=(migr(a,2)+4));
   temp=temp(k,:);
   b=max(temp(:,1));
   k=find(temp(:,1)==b);
   ascending=[ascending;temp(k,:)];
end

clear a k temp b

descending=[];
for a=1:rows
   k=find(data(:,2)>=migr(a,1)-.1 & data(:,2)<migr(a,1)+.1);
   temp=data(k,2:3);
   k=find(temp(:,2)>=(migr(a,2)-4) & temp(:,2)<=(migr(a,2)+4));
   temp=temp(k,:);
   b=find(min(temp(:,1)));
   descending=[descending;temp(b,:)];
end

clear a k temp b rows cols migrations

temp=[]; asc=ascending;
a=1;
while a<=length(asc)
   temp=[temp;abs(asc(a+1,1)-asc(a,1)) abs(asc(a,2)-asc(a+1,2))];
   a=a+2;
end

temp(:,1)=temp(:,1)*86400;

ascrate=[];
for a=1:length(temp)
   ascrate=[ascrate;temp(a,2)/temp(a,1)];
end

clear temp asc b k a

temp=[]; desc=descending;
```

```
a=1;
while a<=length(desc)
   temp=[temp;abs(desc(a+1,1)-desc(a,1)) abs(desc(a+1,2)-desc(a,2))];
   a=a+2;
end

temp(:,1)=temp(:,1)*86400;

descrate=[];
for a=1:length(temp)
   descrate=[descrate;temp(a,2)/temp(a,1)];
end

clear temp desc b k a fish
```

zstat.m

```
dawnmean=mean(dawn(:,3));
daymean=mean(day(:,3));
duskmean=mean(dusk(:,3));
nightmean=mean(night(:,3));

dawnvar=var(dawn(:,3));
dawnstderr=sqrt(dawnvar/length(dawn));
dayvar=var(day(:,3));
daystderr=sqrt(dayvar/length(day));
duskvar=var(dusk(:,3));
duskstderr=sqrt(duskvar/length(dusk));
nightvar=var(night(:,3));
nightstderr=sqrt(nightvar/length(night));
```

VITA

Harmon Brown was born in Angleton, Texas, in July, 1969. He graduated from Mt. Pleasant High School in Mt. Pleasant, Texas, in 1987 before serving in the US Army in Colorado and Germany. Harmon earned his Bachelor of Science in biology (marine biology and limnology) in 1998 and his Master of Arts in marine biology in 2001 from San Francisco State University in San Francisco, California. Harmon came to Louisiana State University on a Board of Regents Fellowship in environmental economics in 2003, before transferring into the doctoral program in the Department of Oceanography and Coastal Sciences in 2004.